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Mariners Weather Log

National Oceanic and Atmospheric Administration • Environmental Data and Information Service

Mariners Weather Log

Editor: Elwyn E. Wilson
Editorial Assistant: Annette Farrall

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Cover: Patiently waiting for the arrival of the Coast Guard icebreaker ACACIA, the H. LEE WHITE is stopped by Lake Michigan ice on January 11, 1978, about 1/2 mi from her destination, Burns Harbor. This past winter was a record-breaking year for the number of Coast Guard assists. For details see article, "Great Lakes Ice Season, 1977-78," on page 401. Wide World Photo.

ARTICLES

HINTS TO THE OBSERVER - TIPS TO THE RADIO OFFICER

HURRICANE ALLEY

ON THE EDITOR'S DESK

MARINE WEATHER REVIEW

MARINE WEATHER DIARY

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Mariners Weather Log

TOKYO BAY AS A TYPHOON HAVEN

Samson Brand
Naval Environmental Prediction Research Facility
Monterey, Calif.

Russell J. Graff
Naval Postgraduate School
Monterey, Calif.

Dick DeAngelis
Environmental Data and Information Service, NOAA
Washington, D.C.

Editor's Note: This is the fourth in a series of articles evaluating the safety of ports as shelters from tropical cyclones. These are edited versions of studies that appear in the Typhoon Havens Handbook for the Western Pacific and Indian Oceans by Samson Brand and Jack W. Blelloch, June 1976, Naval Environmental Prediction Research Facility, Monterey, Calif.

Tokyo Bay is the site of two major commercial ports, Tokyo and Yokohama, as well as several smaller ports, both military and commercial. The heavy traffic in and out of the Bay could pose a probelm during times of rough weather. Fortunately, Tokyo Bay offers good shelter against tropical cyclones.

The original study done for the U.S. Navy used the port of Yokosuka; however, the general findings are applicable to Tokyo Bay. For specific details on Yokosuka, see the original report.

THE SETTING

Tokyo Bay penetrates the southeast coast of Honshu in a northerly direction for a distance of almost 35 mi. Approximately 200 ships transit Uraga Suido,[1] the entrance to Tokyo Bay, daily. The ports of Yokosuka, Yokohama, and Tokyo are in Tokyo Bay (fig. 1).

The terrain immediately adjacent to Tokyo Bay is low, but to the west and northwest are high mountains. The island of Honshu is one of the most rugged of land areas (fig. 2). The mountains in the north central area average 5,000 to 10,000 ft in height and are often called the Japanese Alps. The highest mountain, Fujiyama (12,395 ft), is 60 mi due west of Yokosuka. Northern Honshu is less mountainous.

Note the relative flatness of the terrain north and east of Tokyo Bay as compared with the terrain to the west and northwest. Southern Honshu is even less jagged with no peaks rising over 5,000 ft. The rugged

[1]Uraga Suido is a controlled traffic route, one of several controlled routes established by the Japanese Maritime Safety Agency to regulate shipping traffic in highly congested areas in an effort to avert marine accidents.

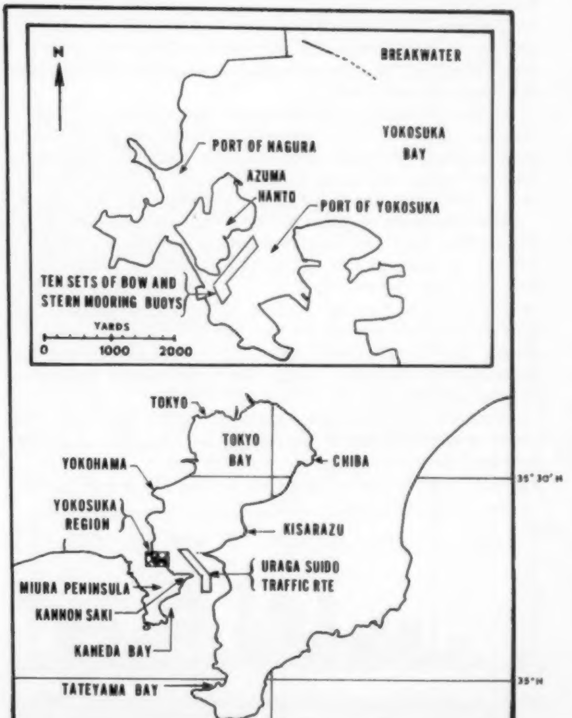


Figure 1.--Tokyo Bay and the surrounding land area. The Yokosuka region is enlarged at the top of the figure.

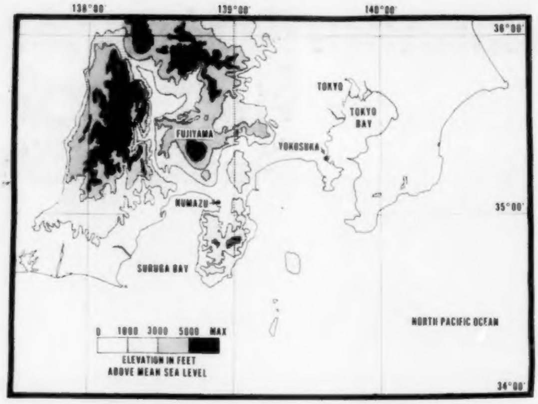


Figure 2.--Topography of central Honshu.

terrain of Honshu influences the weather over Tokyo Bay.

Yokosuka Bay is at the southwestern end of the inner part of Tokyo Bay. The harbor of Yokohama, a large commercial port, is about 10 mi northward of Yokosuka Bay. Tokyo Harbor is about 20 mi north-northeastward of Yokosuka.

THE CLIMATOLOGY

Tropical cyclones which affect Tokyo Bay generally form in an area bounded by latitudes 5° and 30°N and longitudes 120° and 165°E. The latitudinal boundaries shift poleward during the summer and then equatorward in winter in response to the seasonal changes of the synoptic environment.

In this genesis area typhoons have occurred in all months, but with rare exceptions those affecting the main Japanese Islands occur in May through November. Late summer and early autumn are the likeliest seasons. Size and intensity of the storms vary widely.

The majority of those storms that pose a threat to Tokyo Bay (any tropical cyclone approaching within 180 mi of Yokosuka is defined as a "threat") occur in June through October (fig. 3). A total of 82 tropical cyclones passed within 180 mi of Yokosuka during the May-November period for the years 1947-73. Of these, 76 (93 percent) tropical cyclones passed during June through October, while the remaining 6 passed in May and November, 3 in each month.

Most of these storms approach Tokyo Bay from the south-southwest and west-southwest (fig. 4). A more detailed inspection reveals that only nine (12 percent) did not recurve before passing within 180 mi of Yoko-

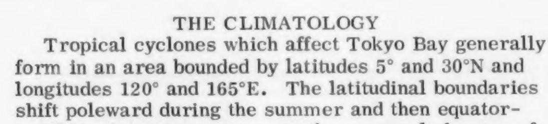


Figure 3.--Frequency distribution of number of tropical cyclones that passed within 180 mi of Yokosuka. Subtotals are based on 5-day periods for tropical cyclones that occurred during 1947-73.

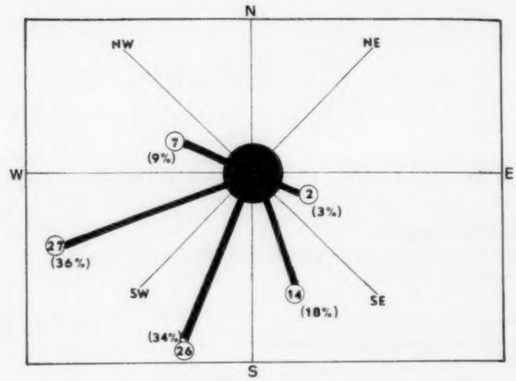


Figure 4.--Octant from which tropical cyclones approached to within 180 mi of Yokosuka (June-Oct., 1947-73). Circled numbers indicate the number that approach from each octant. Number in parenthesis is the percentage of total sample of 76 that approached from that octant.

suka.

Figures 5 through 9 show the percentage of tropical cyclones that have passed within 180 mi of Yokosuka (can be interpreted as a probability of threat) for each month, June through October. The solid lines show a "percent threat" for any tropical cyclone within the area examined. Dashed lines represent the approximate time in days for a system to reach Yokosuka. For example, in figure 5 a tropical cyclone at 28°N, 136°E, has a 50 percent probability of passing within 180 mi of Yokosuka and will reach Yokosuka in about 1 day.

The speed range for figures 5 through 9 was based on the assumption that as tropical cyclones recurve, their forward speed slows to about 10 kn during recurvature. It should be expected that the system will subsequently accelerate rapidly toward the north or northeast. Speeds of 20 to 30 kn are common, and speeds as great as 50 kn have been observed.

During 1952-73, 64 tropical cyclones passed within 180 mi of Yokosuka during June through October (about 3 per year). The extent of winds observed at Yokosuka for these storms is shown in table 1. Tracks of the 20 tropical cyclones that had gale-force winds or greater at Yokosuka for this same period are shown in figures 10 and 11. When these tracks are compared with the climatology for all tropical cyclones, it can be seen that while tropical cyclones have approached Yokosuka from virtually all southerly directions, the vast majority approach along a threat axis that is oriented generally southeast to west-southwest from Yokosuka. This threat axis is also evident in figures 5 through 9 by the "percent threat" lines.

Most September tropical cyclones passed west of Yokosuka and initially struck Japan on the south coast of Honshu. Recurvature generally occurred farther south for the September and October tropical cyclones than for the July and August systems.

The observation station for the Naval Weather Service Facility (NWSF), Yokosuka, is located on top of a 175-ft hill, and the wind instrument is another 55 ft above the station. The observed wind velocity is about

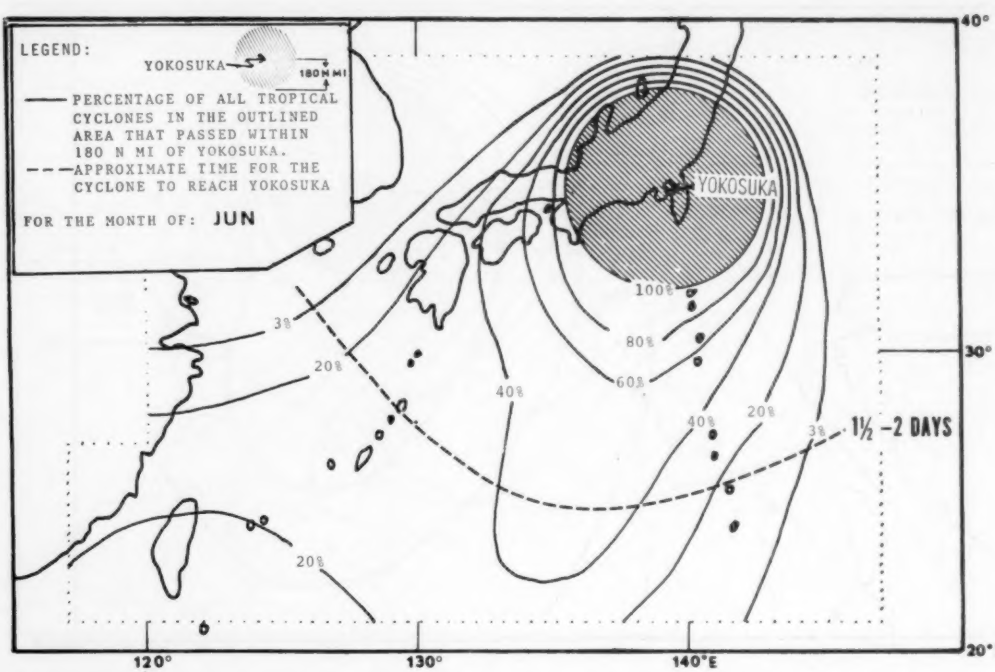


Figure 5.--Probability that a tropical cyclone will pass within 180 mi of Yokosuka in June (based on data from 1947-73).

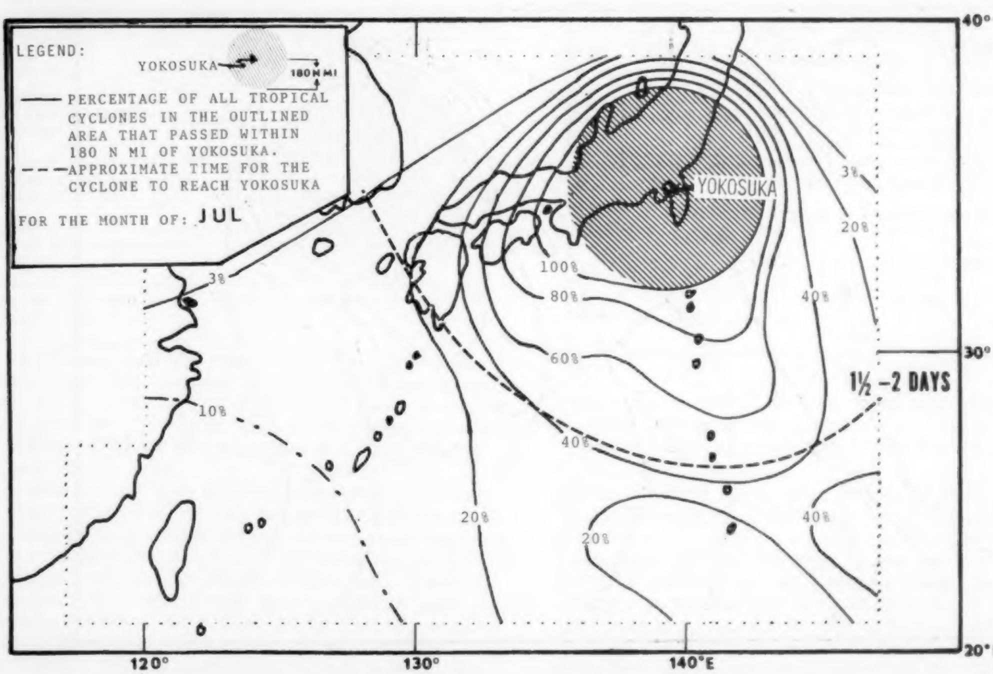


Figure 6.--Probability that a tropical cyclone will pass within 180 mi of Yokosuka in July (based on data from 1947-73).

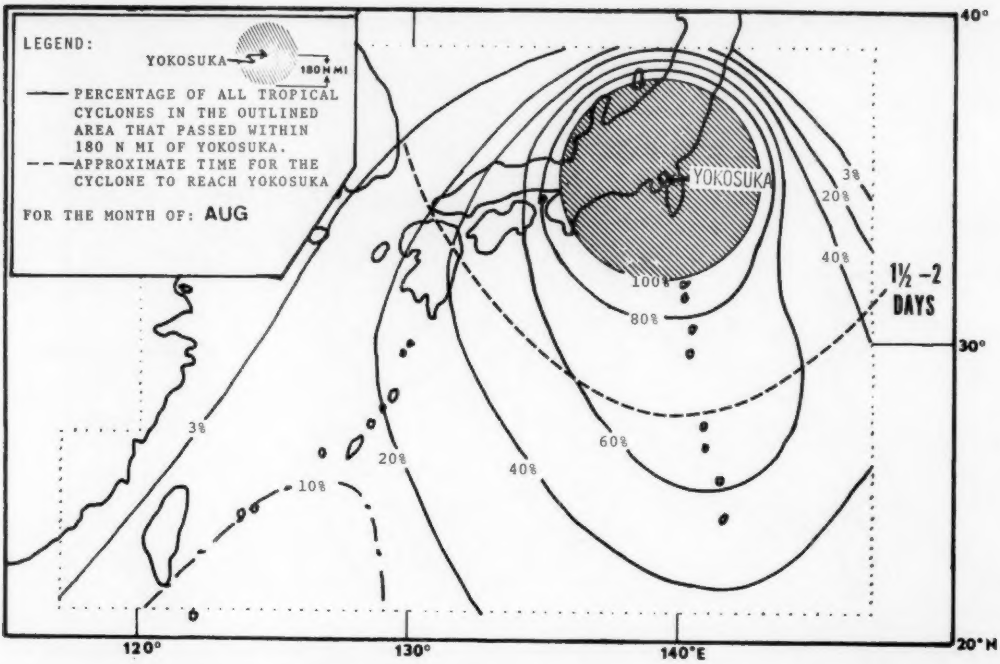


Figure 7.--Probability that a tropical cyclone will pass within 180 mi of Yokosuka in August (based on data from 1947-73).

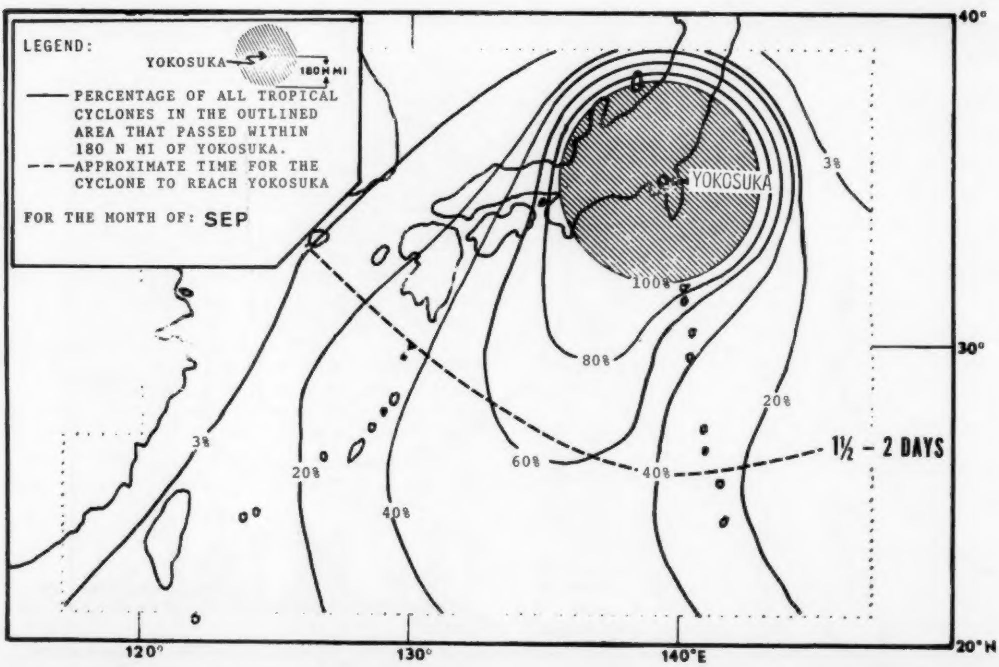


Figure 8.--Probability that a tropical cyclone will pass within 180 mi of Yokosuka in September (based on data from 1947-73).

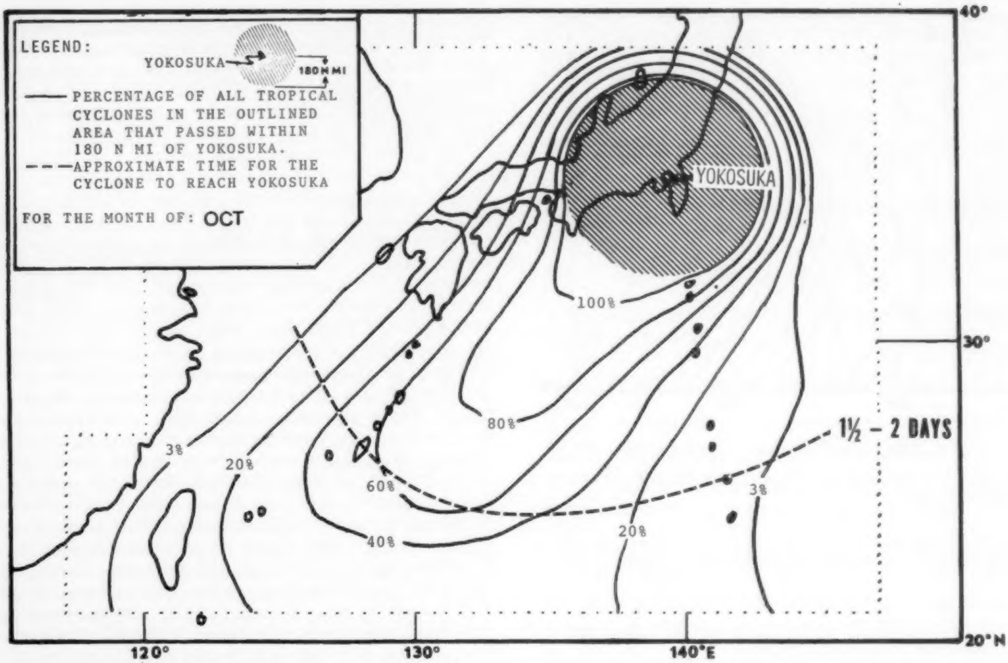


Figure 9.--Probability that a tropical cyclone will pass within 180 mi of Yokosuka in October (based on data from 1947-73).

Table 1.--Tropical cyclones affecting Yokosuka, 1952-73

	June-Oct.	Aug.	Sept.
Number of tropical cyclones that passed within 180 mi of Yokosuka	64	22	19
Number of tropical cyclones with strong (≥22 kn) winds at Yokosuka	47 (73%)	14 (64%)	15 (79%)
Number of tropical cyclones with gale-force (≥34 kn) winds at Yokosuka	20 (31%)	5 (23%)	11 (58%)

Based on hourly data provided by Naval Weather Service Detachment, Asheville, N.C.

10 kn greater than that observed in the harbor, but otherwise is representative. The highest recorded wind (gust) in Yokosuka during 1953-73 was from the south at 96 kn. It was attributed to typhoon Ida, which passed about 20 mi to the northwest of Yokosuka on September 26, 1958.

Winds in the Tokyo Bay region during the passage of a severe tropical cyclone are greatly influenced by the surrounding topography and the extent of this influence is dictated by the direction of approach of the storm and the passage relative to the Bay. From an analysis of the tracks, it is apparent that tropical cyclones can pass to the east or to the west and result in gale-force winds or greater. The basic difference between the two passages is the direction of the resultant wind on the harbor. If the tropical cyclone passes to the west of Yokosuka, the winds will generally be from the south. For a passage to the west, the storm must necessarily cross the mountain ranges of Honshu. An example of this was typhoon Nancy (September 1961), which had a closest point of approach (CPA) of 140 mi west-northwest of Yokosuka. Nancy pounded the harbor with gusts of 71 kn from the south-southwest and a sustained wind of about 50 kn for 4 hr.

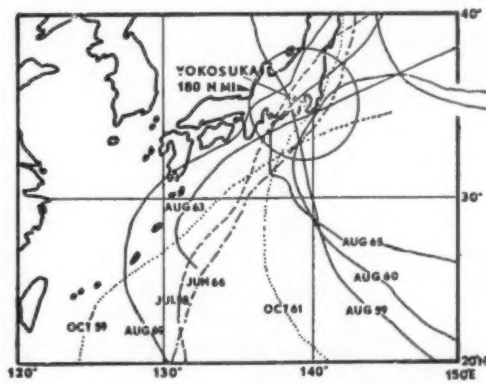


Figure 10.--Tracks of nine tropical cyclones with winds ≥ 34 kn at Yokosuka for June, July, August, and October (based on data from 1952-73).

If the tropical cyclone passes to the east of Yokosuka, the path will be over water and the winds will be generally northerly. An example of this was typhoon Violet (October 1961) which had a CPA of 30 mi to the

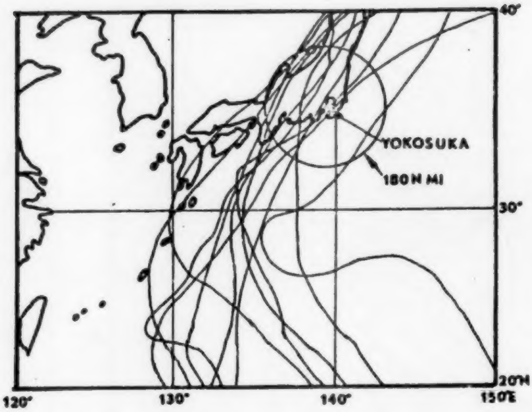


Figure 11.--Tracks of 11 tropical cyclones with winds $\geq$ 34 kn at Yokosuka for September (based on data from 1952-73).

southeast of Yokosuka. As a result of Violet, the harbor experienced gusts of 74 kn from the north-northeast.

Units of the U.S. Navy's Seventh Fleet in port Yokosuka during the threatening times of Nancy and Violet reported negligible damage.

As shown in figure 12, 60 percent of the tropical-cyclone tracks associated with gale-force winds or greater at Yokosuka passed to the west of Yokosuka. The winds in Yokosuka generally first exceeded 33 kn when the storm's center was to the north and east of Yokosuka. A number of times tropical-cyclone centers were nearly 300 mi to the north and east, yet gale-force winds were observed at Yokosuka.

The port of Yokosuka experiences very little wave action as the result of a typhoon transiting the vicinity. The amount of wave action will vary according to whether the typhoon passes to the west or to the east of the port with resulting southerly or northerly winds, respectively. The surrounding land masses and the breakwater located near the entrance to Yokosuka Harbor are major factors in limiting the wave action in the port of Yokosuka. Wave action will be greater for a northerly wind (typhoon passage to the east). The port of Yokosuka opens onto Tokyo Bay in a north-northeast direction for a distance of about 25 mi. Prior to arriving at Yokosuka any wind-generated waves from a northerly direction must traverse various natural and manmade obstacles, hence much of the energy contained in these waves is depleted.

An estimate of the maximum wave height that may be encountered for typhoon-force winds in the region about Yokosuka and Tokyo Bay is summarized in table 2. The major factors considered in this listing were the direction of tropical-cyclone passage relative to Yokosuka, the direction and speed of the resultant typhoon-force winds, the length of fetch, a duration greater than 1 hr but less than 5 hr, and the location of obstacles in the path of the progressing waves.

Storm surge may be defined as an abnormal rise

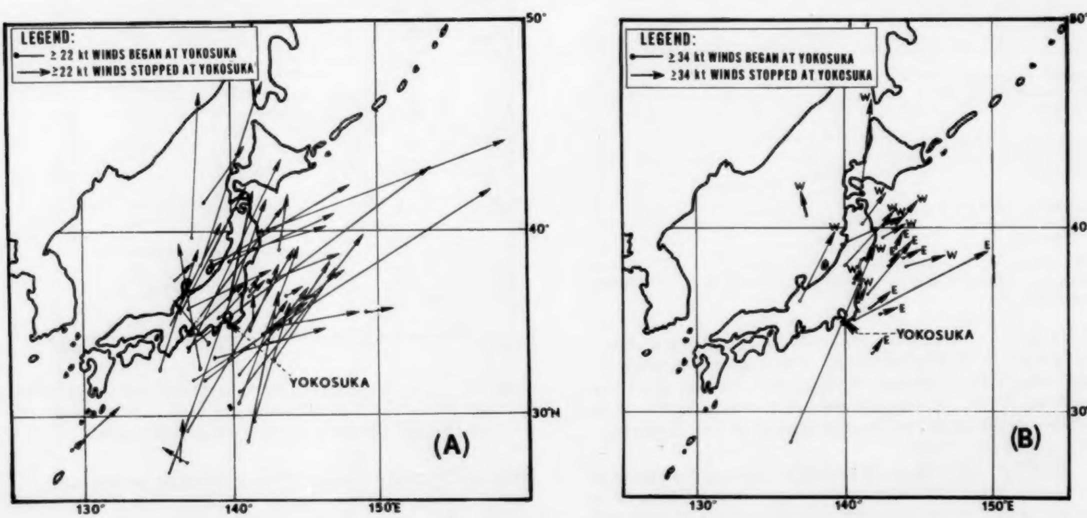


Figure 12.--Positions of 20 tropical-cyclone centers when 34-kn winds first and last occurred at Yokosuka (based on hourly wind data for June-Oct., 1952-73). The letter at the arrowheads shows the direction of the closest point of approach of the associated tropical cyclone to Yokosuka.

Table 2.--Approximate maximum wave heights (ft) for Yokosuka region and Tokyo Bay

Wave height (ft) in the vicinity of	Direction of passage of tropical cyclone relative to Yokosuka	
	East	West
Port of Yokosuka	6 ft	3 ft
Yokosuka Bay	9 ft	5 ft
Tokyo Bay (about 10 mi north-northeast of Yokosuka	12 ft	11 ft

of the sea along a shore as the result of the winds of a storm and the pressure drop. The piling up of water on a coast ahead of a tropical storm or typhoon is more apparent in the dangerous semicircle, when a typhoon passes to the west of the area.

The storm surges are more pronounced along the south coast of the Japanese Islands west of Tokyo Bay. Tokyo Bay opens onto the south coast of Honshu. The surge forms to a large extent after entering the inland bays, since the width of the continental shelf is generally narrow along the Japanese coast. Most of the surge occurs, therefore, at the inshore side of these bays, not along the open coast nor near the mouth of the bays. During the period 1900-73, peak surges of 7.6 ft (October 1919) and 7.3 ft (September 1938) were observed at the inshore side of Tokyo Bay. They were the result of southerly winds caused by typhoons passing generally to the west of Tokyo Bay.

Due to its sheltered position within Tokyo Bay and its location near the entrance, Yokosuka experiences very little storm surge. Conversations with civilian employees of the Port Services Office, Yokosuka, indicate that storm surges of about 3 ft have been felt within the harbor, but have not been a problem. Surges of this magnitude coupled with the normal tide range of 4 to 5 ft in June through October do not present any unusual difficulty to vessels, if mooring lines are tended.

THE DECISION

The port of Yokosuka is a "safe" typhoon haven--a port in which to remain if already there or in which to seek shelter if at sea when threatened by a typhoon. The primary factors in reaching this conclusion are:

1. The port provides shelter from wind and sea due to the surrounding land masses.

2. Wave action induced by typhoons has been negligible in the port.

3. Storm surge has negligible effect.

4. The orientation of the berths and drydocks with respect to the local topography is good.

5. The experience level and the high degree of competence of the Port Services personnel.

6. The only situation in which the port would not be a safe haven is when a very intense typhoon ($\geq$ 120 kn) passed directly over Yokosuka.

7. The history of the port. Conversations with Japanese employees at Fleet Activities, Yokosuka, indicated that since 1945 there is no recollection of U.S. Navy, Japanese Maritime Self Defense Force, or merchant ships sortieing from the port of Yokosuka due to a typhoon. It should be noted, however, that the port has never been truly tested as a haven by U.S. Navy aircraft carriers.

Figures 13 to 17 give the tropical-cyclone threat axis for Yokosuka for each month, June through October. The orientation of the threat axis was derived

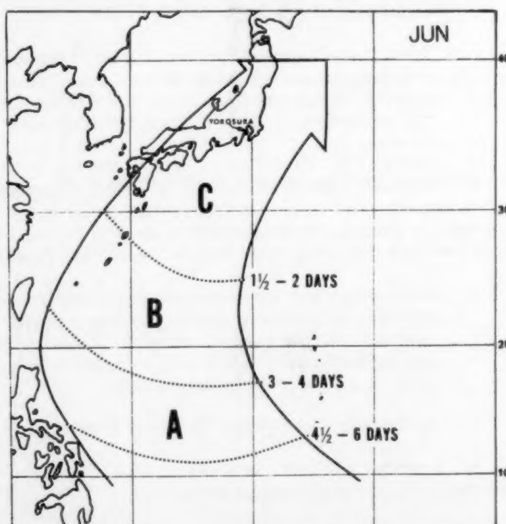


Figure 13.--Tropical-cyclone threat axis for Yokosuka for June.

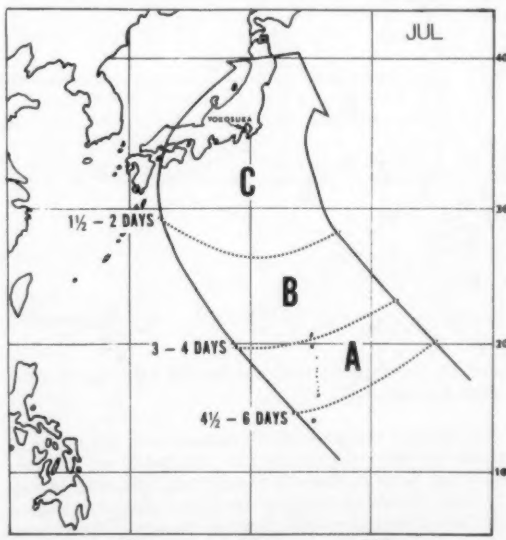


Figure 14.--Tropical-cyclone threat axis for Yokosuka for July.

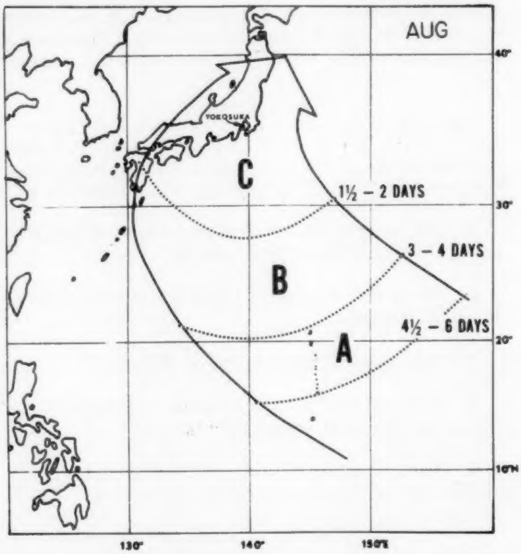


Figure 15.--Tropical-cyclone threat axis for Yokosuka for August.

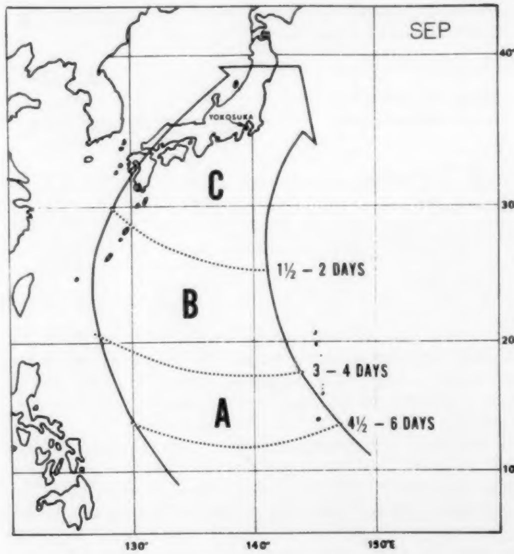


Figure 16.--Tropical-cyclone threat axis for Yokosuka for September.

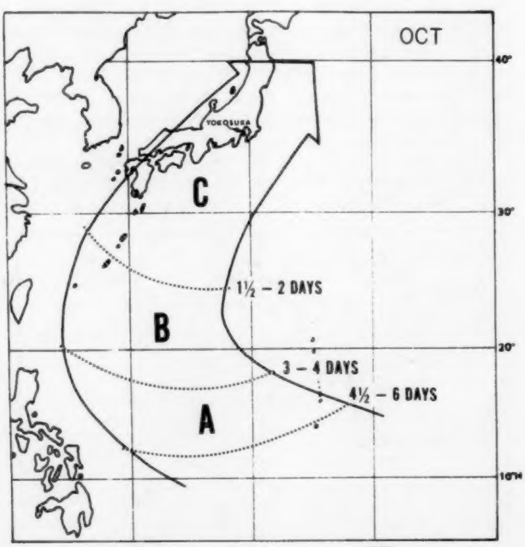


Figure 17.--Tropical-cyclone threat axis for Yokosuka for October.

by considering the general direction from which the tropical cyclones approached to within 180 mi of Yokosuka. The time in days to reach Yokosuka was based on typical speeds of tropical cyclones affecting Yokosuka. In conjunction with figures 13 to 17, the following time table has been set up to aid in decisionmaking.

1. An existing tropical cyclone moves into or development takes place in Area A with long range forecast movement toward Yokosuka (recall that about 40 percent of all tropical storms and typhoons recurve):

a. Review material condition of ship.

b. Reconsider any maintenance that would render the ship incapable of riding out a storm or typhoon with the electrical load on ship's power, or would render the ship incapable of getting underway, if need be, within 48 hr.

c. Plot Fleet Weather Central / Joint Typhoon Warning Center (FWC/JTWC), Guam, warnings, if issued, and construct the danger area. Reconstruct the danger area for each new warning.

2. Tropical cyclone enters Area B with forecast movement toward Yokosuka (recall that prior to recurvature tropical cyclones tend to slow in their forward motion and after recurvature accelerate rapidly):

a. Reconsider any maintenance that would render the ship incapable of shifting to a new berth assignment, anchorage, or buoy or otherwise getting underway, prior to the commencement of strong winds within the harbor.

b. Anticipate Storm/approximately 2 days away.

3. Tropical cyclone has entered Area C and is moving toward the Yokosuka area:

a. Anticipate Storm, take all necessay precautions.

A high-velocity wind is the single most important factor to be considered. The effects of wave action

and storm surge are negligible in the port of Yokosuka.

THE EVASION

Ships have, in the past, anchored in Tateyama Bay for typhoon passage to the east of Tokyo Bay. They also make use of Kisarazu Harbor. Merchant vessels have at times, depending on the direction of the tropical storm or typhoon CPA, anchored in the following areas:

1. Tropical-cyclone passage to the east or south of Tokyo Bay - anchor in Chiba Harbor or Kisarazu Harbor.

2. Tropical-cyclone passage to the west or north of Tokyo Bay - anchor in Kaneda Bay.

Vessels carrying dangerous cargo must anchor as directed by the Japanese Maritime Safety Office. Ships requiring a pilot to transit the Uraga Suido Traffic Route may be unable to secure pilot services if winds are greater than about 35 kn, because pilots embark and debark from small motor launches.

Remaining in port is, in almost all instances, the recommended course of action when a tropical storm or typhoon threatens. When there are crowded conditions within the port of Yokosuka and thus limited pierside facilities, a ship may elect to evade the typhoon at sea or anchor in Tokyo Bay.

The port of Nagura (see fig. 1) is considered a good typhoon haven if a ship is pierside. However, ships anchored in the vicinity of Nagura or moored to a buoy usually get underway and proceed to anchorages in various parts of Tokyo Bay.

The widely held doctrine of evasion at sea rather than remaining in port for the single purpose of minimizing typhoon-related damage is not generally recommended when in port at Yokosuka or in Tokyo Bay. If putting to sea is desirable, however, each tropical storm or typhoon must be considered as differing from those preceding it. The accompanying synoptic situation must be fully understood. To establish one technique or rule to avoid the danger area is not practical. The Japanese say that, "the only solution is that there is no one solution."

In general, the effects of sea and swell generated by a tropical cyclone generally begin to be felt in the vicinity of Kannon Saki and may reduce the speed of advance (SOA), thereby increasing the time required to reach the open sea. If a ship is caught in the sea and swell pattern ahead of a tropical cyclone, in particular a typhoon, the SOA may be reduced to the point that the ship will be unable to maneuver to clear the danger area. If the typhoon is forecast to follow a recurving track, with a CPA east of Yokosuka, then a course downsea/downwind, in the left or navigable semicircle may be advisable.

Any course to the north along the east coast of Honshu is considered unwise. The possibility of being overrun exists if the storm accelerates and/or turns to the north suddenly. The average speed of advance in the higher latitudes (30° to 40°N) of tropical cyclones is about 25 kn; however, they have been tracked as fast as 50 kn. Typhoon wind intensities tend to decrease as the system moves into the northern latitudes, but nevertheless can be quite destructive.

THE NATIONAL OCEANOGRAPHIC DATA CENTER

Richard J. Abram
Environmental Data and Information Service, NOAA
Washington, D.C.

Diners at the Sir Walter Raleigh Inn restaurant just north of the fashionable Georgetown area of Washington, D.C., would probably be surprised to know that the plain red brick building in which they are enjoying their steaks and salad also houses the world's largest collection of oceanographic data. Since 1974, the Page Building complex on Wisconsin Avenue has been the home of the National Oceanographic Data Center (NODC), an organization that is unique in the United States and the first of its kind in the world.

The NODC was created in response to the rapid growth of earth science research following World War II. By the time this accelerating pace of research culminated in the International Geophysical Year (IGY) of 1957-58, a wealth of new oceanographic data was being gathered by scientists from dozens of different countries. But researchers found easy access to this data resource hampered by its being scattered in separate collections around the country and around the world. A new kind of institution--a National Oceanographic Data Center--was finally proposed by oceanographers, various science advisory panels, and members of Congress to meet this need for a central facility that could acquire, process, archive, and disseminate oceanographic data.

Formally established in 1960 under the terms of an agreement among 10 Federal agencies with oceanographic interests, the NODC was organized and first administered by the U.S. Naval Oceanographic Office. In 1970, however, a new agency, the National Oceanic and Atmospheric Administration (NOAA), was formed within the Department of Commerce. NOAA joined together under a single umbrella the bulk of the Nation's civilian government research and service organizations in the oceanic and atmospheric sciences. At this time the NODC became part of NOAA's Environmental Data Service, which was recently rechristened the Environmental Data and Information Service (EDIS) to more accurately reflect its activities. For several more years, however, NODC remained at its original--and perhaps more appropriately nautical--location, the historic Washington Navy Yard (referred to affectionately by oldtimers as the "gun factory" from the days when its foundries supplied much of the fire-power on America's fighting ships).

At the Page complex the NODC is part of the NOAA family both organizationally and physically. Fellow tenants include groups from the National Marine Fisheries Service, the Office of Coastal Zone Management, and other components of the Environmental Data and Information Service. But despite these changes, the NODC's mission remains the same--to provide oceanographic data and information to scientists, engineers, other technical users, and the general public.

The Center's data bases are worldwide in coverage. Figure 18, for example, shows a location plot of all NODC-archived oceanographic station data observations (mostly Nansen casts) for the remote seas around Antarctica for the 6 mo from October through March (the so-called "austral summer"). The NODC obtains foreign data by direct exchange with individuals and organizations in other countries, and through World Data Center A, Oceanography, a part of the World Data Center system that was established during the IGY to facilitate international data exchange. The World Data Center A, Oceanography is collocated with and administered by the NODC.

Among the largest and most important NODC data bases are the Oceanographic Station Data File, the Mechanical Bathythermograph (MBT) Data File, the Expendable Bathythermograph (XBT) Data File, and the Surface Current Data System (SCUDS). The current sizes of these data bases are given in table 3.

The Oceanographic Station Data File contains physical-chemical data taken at a series of depth levels while the observing ship is at a fixed location, or "on station." Besides measured values of temperature and salinity versus depth, each record contains values of computed quantities such as density and sound velocity. Concentration of oxygen, phosphate, nitrate, and other nutrient chemistry data is often reported also. Although the file consists primarily of Nansen cast observations, it includes some low-resolution salinity-temperature-depth (STD) recorder data. Many of these observations extend to depths of at least 1,200 m, with some much deeper.

The MBT and XBT files contain digital records of temperature versus depth that are derived from the original MBT slides and XBT strip charts. These files are useful for studying ocean thermal structure and the depth of the thermocline. Because the XBT instrument is easier to use and can go deeper (to 450 m or more) than the MBT, the older MBT is now essentially obsolete and no longer used by U.S.

Table 3.--Selected NODC Data Bases (as of October 1, 1978)

Oceanographic Station Data	626,888 stations
Mechanical Bathythermograph (MBT) Data	765,169 observations
Expendable Bathythermograph (XBT) Data	304,000 observations
Surface Current Data System (SCUDS)	4,175,324 observations

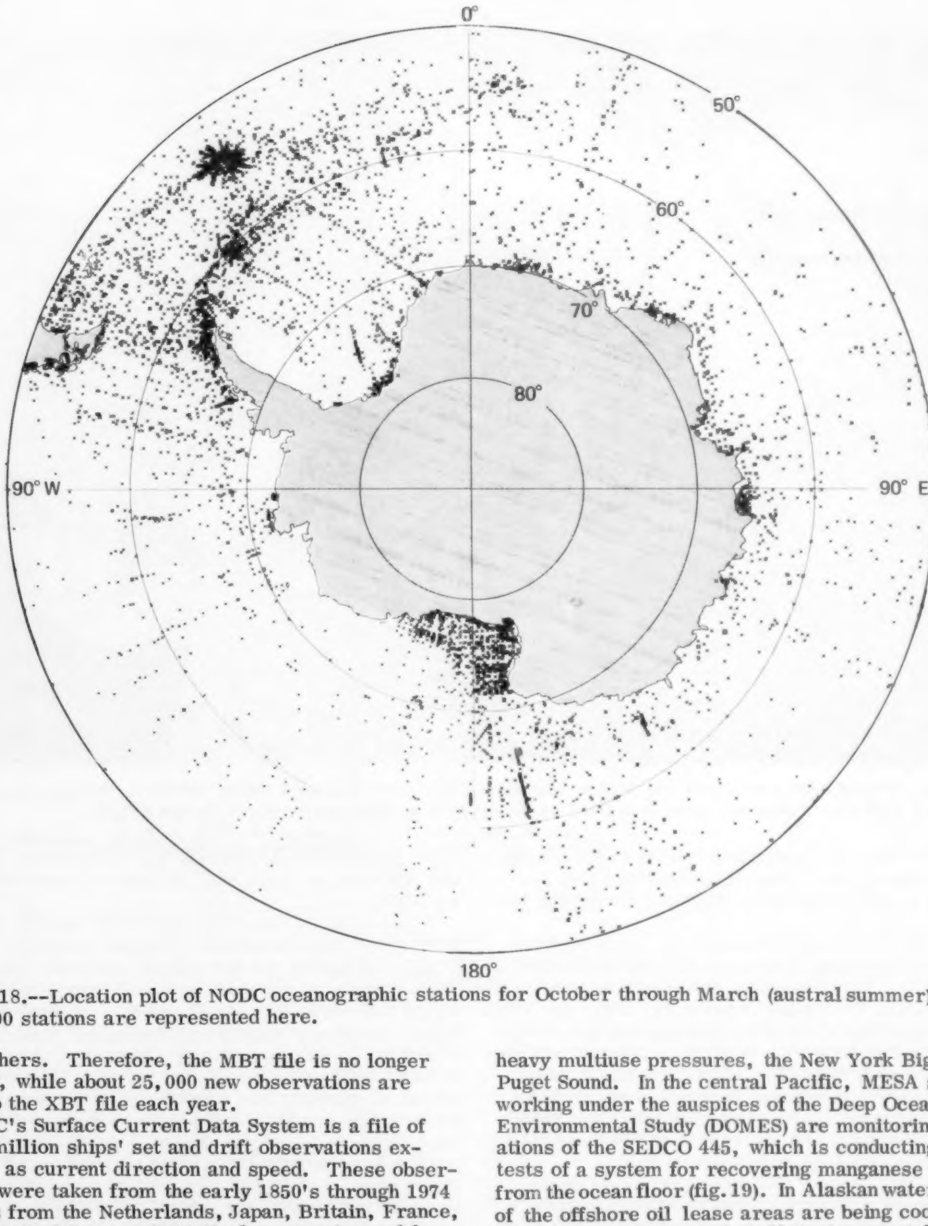


Figure 18.--Location plot of NODC oceanographic stations for October through March (austral summer). Over 5,700 stations are represented here.

researchers. Therefore, the MBT file is no longer growing, while about 25,000 new observations are added to the XBT file each year.

NODC's Surface Current Data System is a file of over 4 million ships' set and drift observations expressed as current direction and speed. These observations were taken from the early 1850's through 1974 by ships from the Netherlands, Japan, Britain, France, and the United States. Statistical summaries and frequency distributions can be produced from this file for any month or group of months for ten-, five-, two-, one-, one-quarter-, or one-tenth-degree squares.

In addition to these large, heavily used data files, the NODC archives contain many smaller data files and special data sets. And the NODC is also now receiving increasing amounts of data from a number of special projects designed to study the effects of man's technology on the marine environment.

The Marine Ecosystems Analysis (MESA) Program, for example, is concentrating on two areas subject to heavy multiuse pressures, the New York Bight and the Puget Sound. In the central Pacific, MESA scientists working under the auspices of the Deep Ocean Mining Environmental Study (DOMES) are monitoring the operations of the SEDCO 445, which is conducting the first tests of a system for recovering manganese nodules from the ocean floor (fig. 19). In Alaskan waters studies of the offshore oil lease areas are being coordinated by the Outer Continental Shelf Environmental Assessment Program (OCSEAP). The ambitious goal of these and similar projects is to enable man to both monitor and predict the environmental consequences of his actions and to develop the resources of the sea wisely.

To reach this goal, researchers are collecting and sending to the NODC a wider range of marine data than ever before. Digital data formats, or "file types," have already been developed for recording and archiving 45 different kinds of data ranging from hydrocarbon and trace element concentrations to fish pathology observations and marine mammal sightings. The NODC

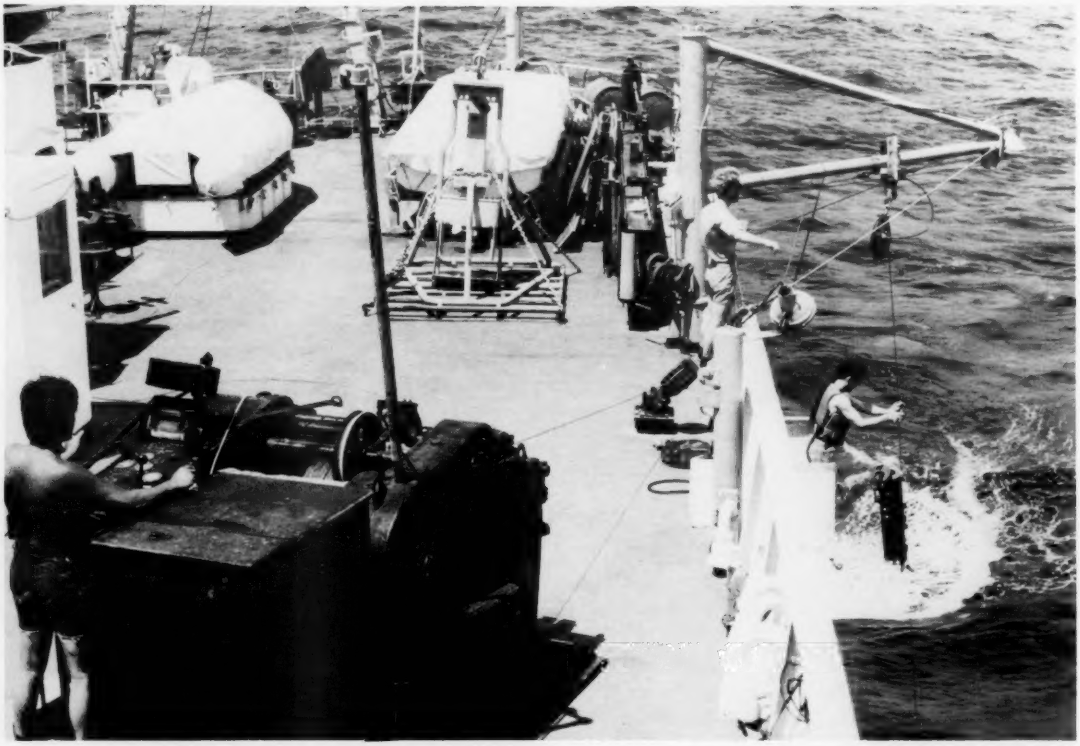


Figure 19.--Researchers onboard the NOAA ship OCEANOGRAPHER take water samples during the early phase of DOMES. Oceanographic data from projects such as this are archived by the NODC.

is also developing an automated archival and retrieval system to ensure that this multidisciplinary data can be handled as efficiently as its standard oceanographic data.

One of the NODC's greatest achievements in automated data processing is its Generalized Application System (GAS). This integrated set of computer programs accesses the Station Data, MBT, XBT, SCUDS, and other data files to produce data summaries, analyses, and graphic displays. Products currently available include vertical and horizontal data summaries, thermocline and mixed-layer analyses, temperature-salinity histograms, vertical section plots, and horizontal contour plots. An example of one of these GAS computer products is shown in figure 20.

GAS exploits the fact that most NODC data bases have a common structure. They contain measured parameters versus depth at a fixed location taken at a given time. Therefore, instead of writing computer programs to deal with the peculiarities of each file, a single conversion module was developed to extract the required data from the archive file and reduce it to a single format. Furthermore, the applications programs access this GAS-formatted data through intermediary read and write subroutines. In this way the applications programs are completely insulated from future changes in either the data files or in the GAS format itself. If such changes are ever required, the numerous, complex applications programs will not have to be modified. Only the GAS conversion module and the read and write subroutines will have to be rewritten.

The computer also helps the NODC answer three frequently asked questions: (1) How much data is in NODC's data files for my area of interest? (2) Are there other environmental data collections held elsewhere that cover this area? and (3) Are there published reports or journal articles on my topic of interest? The first question can be answered by the NODC's online data inventory system. This system allows an operator at a graphic computer terminal to produce location plots and counts of observations by ten-, five-, two-, or one-degree squares for a selected area and specified criteria such as year, month, country, cruise, and depth. The last two questions can be answered by an online search of the Environmental Data and Information Service's ENDEX/OASIS system. ENDEX (for Environmental Data Index) is a set of computerized data bases containing descriptions of environmental data collections held by Federal, State, and municipal agencies, universities, and private companies and institutions throughout the United States. The Ocean Bottom Photo File and the Instrument-Measured Subsurface Current File, for example, are of particular interest to the oceanographic community. OASIS (for Oceanic and Atmospheric Scientific Information System) provides access to computerized bibliographic data bases such as Oceanic Abstracts,

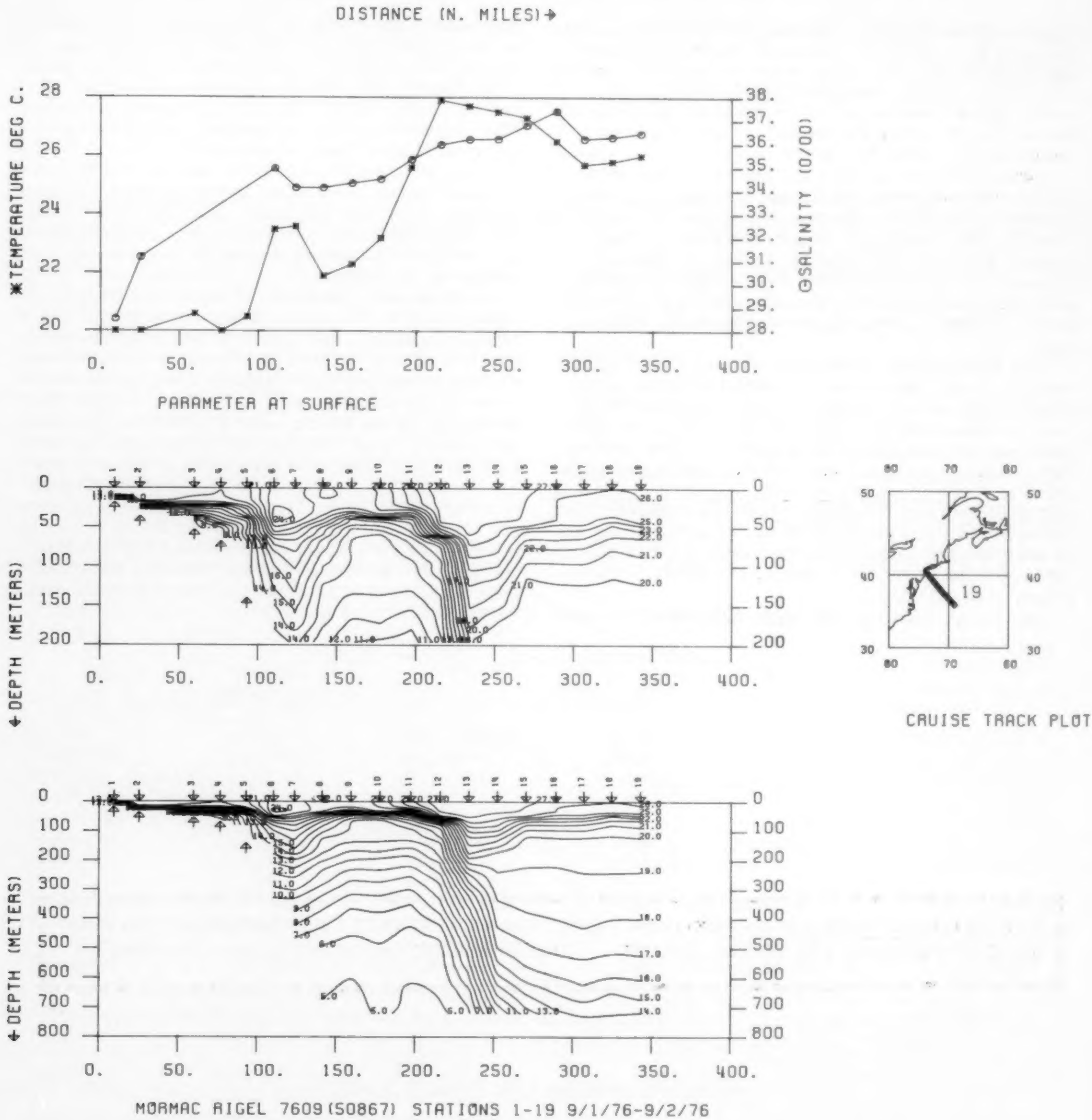


Figure 20.--XBT transect plot produced by the Generalized Application System (GAS).

Pollution Abstracts, and Geoastrophysical and Meteorological Abstracts.

During the past fiscal year, the Center responded to over 4,000 requests for data and information. Many of these requests were from technical users affiliated with leading universities, research institutions, Federal agencies, and private companies with strong marine science programs and projects. The list reads like a "Who's Who" of academia, government, and industry--MIT, Scripps, Woods Hole, the U.S. Navy, Department of Energy, Shell Oil, Texas Instruments, and Lockheed Aircraft. NODC data was used by physical oceanographers studying ocean dynamics, municipal planners concerned with coastal zone management, and engineers working on proposals for the design and siting of Ocean Thermal Energy Conversion (OTEC) plants.

Besides supplying data to technical users, the NODC also responds each year to hundreds of general information requests from teachers, students, and all kinds of other users. In recent months the Center provided information to a researcher from the National Geogra-

phic magazine who was collecting background materials for an article about the continental shelves, a Chilean naval officer who was to serve as navigator on a sailing ship taking part in a race from Rhode Island to Bermuda, and a Canadian schoolboy (undoubtedly inspired by the "Jaws" craze) who wanted to know about "all shark attacks within the last 30 years."

Requests from mariners and others interested in surface oceanography and marine weather are usually handled by the NODC's Marine Climatological Services Branch, often working in conjunction with the Environmental Data and Information Service's National Climatic Center in Asheville, N.C. One of the continuing services provided by the personnel of this Branch is the publication of this magazine, Mariners Weather Log.

The NODC provides small amounts of data or answers to simple information requests free of charge. Larger or more complicated requests are fulfilled at cost or on an exchange basis. In all cases a cost estimate can be given before work begins. The NODC's data holdings, products, and services are described in detail in the User's Guide to NODC's Data Services and NODC Applications Products, which are available free. Requests for these publications and other inquiries can be addressed to the National Oceanographic Data Center (D761), NOAA/EDIS, Washington, DC 20235. Telephone: 202-634-7500.

The NODC wants to make more data and information more easily accessible to more people. As a service to the general public, for example, the NODC--in cooperation with the Sea Grant programs in various states--is producing a new series of recreational guides to coastal resort areas. The sailing weather guides and other summaries of environmental conditions that are contained in these handy brochures should be of special interest to the vacation traveler and the boating enthusiast. The first brochure, Rhode Island's Vacation Climate, is already available, and others for the San Francisco Bay area, North Carolina, Lake Michigan, and southern Chesapeake Bay are in various stages of production or planning.

To help bring its data and the user community closer together, the NODC is exploring ways of using remote terminals, microprocessors, and other advanced computer technology to create a regional network of access points. The idea is to give the user a more direct and active role in getting precisely what he wants. At the present time the EDIS has five Liaison Officers located in the marine-oriented communities of Woods Hole, Miami, La Jolla, Seattle, and Anchorage. They serve the NODC by facilitating the transfer of data to and from hundreds of researchers scattered around the country. In the future it may be possible for the Liaison Officers--and anyone else tied into this network--to make their own quick and easy deposits in or withdrawals from the NODC data bank.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

GREAT LAKES ICE SEASON, 1977-78

Daron Boyce
Great Lakes Ice Forecaster
National Weather Service, NOAA
Cleveland, Ohio

Year-round navigation was resumed on the Great Lakes during the 1977-78 season after an official break during the previous season. It was not accomplished without difficulty, however. Monthly temperature departures for the Great Lakes indicated that temperatures were slightly colder than the previous winter (tables 4 and 5). There was a high level of shipping during the extended season due to an earlier strike. Coast Guard forces were very active and logged a 50-percent increase in mission miles to assist commercial traffic (table 6).

FALL SEASON

On August 1, 1977, about 18,000 members of the United Steelworkers of America went on strike against the iron ore mines and pellet processing plants in Minnesota and upper Michigan. Production was virtually halted by the strike, and some lake boats were layed up within a few days. Others were scheduled up

Table 4.--Departures from normal of Great Lakes air temperatures (°F) for 1977-78 ice season

Month	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario	Overall
November	+0.6	+0.1	+0.1	+2.4	+2.6	+1.2
December	-1.5	-2.6	-2.1	-1.4	-0.1	-1.5
January	-2.6	-5.3	-3.3	-5.8	-2.6	-3.7
February	-2.2	-8.1	-7.3	-11.6	-5.9	-7.5
March	-0.4	-3.2	-3.5	-5.6	-2.6	-3.1
April	-1.9	-2.1	-3.3	-2.3	-2.1	-2.3
Seasonal Average	-1.4	-3.5	-3.2	-4.5	-1.8	-2.85

Table 5.--Maximum accumulated freezing degree days for the 1977-78 season

Station	Maximum accumulated FDD-1977-78	Date	Normal max. accumulated FDD	Date	1977-78 season versus normal
Duluth	2514	March 25-26	2281	April 3	+ 233 (Colder)
Marquette	1354	March 26	1361	March 30	- 7 (Warmer)
Sault Ste. Marie	2050	April 9-10	1702	April 3	+ 348 (Colder)
Green Bay	2016	March 26	1416	March 26	+ 600 (Colder)
Milwaukee	1388	March 18	880	March 15	+ 508 (Colder)
Muskegon	1137	March 10	593	March 16	+ 544 (Colder)
Alpena	1621	March 26	1164	March 28	+ 457 (Colder)
Detroit	1132	March 10	N/A		
Toledo	1418	March 10	343	March 2	+1075 (Colder)
Cleveland	913	March 10	343	February 28	+ 570 (Colder)
Buffalo	1098	March 10-11	489	March 18	+ 609 (Colder)
Rochester	987	March 11	586	March 18	+ 401 (Colder)

A freezing degree day figure is obtained for each site by subtracting the mean temperature for the day from 32°F. Cumulative totals are compiled with negative daily figures (melting degree days) included.

Table 6.--Summary of icebreaking assistance

Fiscal year	Operation hours of direct assistance	Mission miles	Tonnage (GRT) of vessels assisted	Cargo tons carried	Types of cargo
1971	4,080	14,101	3,453,708	2,520,152	Cement, coal, general
1972	2,446	11,765	3,617,431	2,276,384	Grain, iron ore, limestone
1973	1,341	9,494	2,076,701	1,470,995	Petroleum, iron ore, grain
1974	3,872	12,807	3,115,605	1,681,127	Steel, iron ore, wood pulp
1975	2,575	11,275	5,788,909	3,662,653	
1976	2,775	11,586	4,553,832	2,937,083	
1977	5,942	23,131	6,284,304	4,556,724	Taconite, grain, petroleum, steel, coal
1978	6,863	32,322	11,994,519	9,507,274	Petroleum, taconite, cement, grain, steel

the St. Lawrence River to pick up cargoes from mines in Quebec.

In the beginning of September, another 1,000-ft ore vessel entered Great Lakes service. The BELLE RIVER sailed from Lake Superior with a load of coal bound for power plants in Detroit. In spite of the additional capacity, shipments through the Lakes were the lowest in a decade during the fall months because of the strike.

The heat storage of the Lakes was near normal into the fall. Summer temperatures averaged between 1° and 3° below normal over the Lakes region. The National Weather Service outlook for the fall season forecast below-normal temperatures through November. Milder-than-usual weather in September and again in November in the Lower Lakes brought the seasonal departures above normal in spite of a very chilly October. However, persistent cold weather in the Upper Lakes left departures on the negative side for the 3 mo.

In mid-November yet another 1,000-ft carrier entered the shipping fleet. On November 10, the ST. CLAIR established a new record of 41,000 tons of coal out of Presque Isle dock in Toledo, exceeding previous record by 10,000 tons.

By the end of November, continued Arctic outbreaks into the Lakes region lowered water temperatures to critical levels in shallow sections. New thin ice was reported in southern Green Bay and along the shores of both Little and Big Bay De Noc. Two inches of fresh ice had also formed over Duluth Harbor. The ice in Green Bay was enhanced by a post-Thanksgiving snowstorm. Nine inches of snow fell on Milwaukee, and 4 in was measured in Chicago on November 25. Frigid air dropped the temperature to -27°F to equal a record at International Falls the same morning.

The continuing march of early winter storms dropped 2 in of snow on Buffalo on December 2. On the morning of December 4, the mercury had slipped to -8°F in Green Bay--breaking the old mark of -4°F set in 1893. Because of the heavy weather, fears were mounting that some foreign vessels might be trapped in the Lakes for the winter. On December 2 there were 158 ships above St. Lambert. Water temperatures were well below the 10-yr average and even below 1976 levels. The St. Lawrence Seaway was closed officially to inbound traffic.

Two intense storm centers moved through the Lakes region during the week of December 4. By the 6th, Cleveland had accumulated a foot of snow. On the 8th Milwaukee got another 9 in and Chicago 4 in. The next day observers at Marquette, Mich., measured 39 in of snow on the ground. It was -18°F at Alpena on December 11--the coldest there ever in the last month of the year.

The cold weather and high winds associated with the

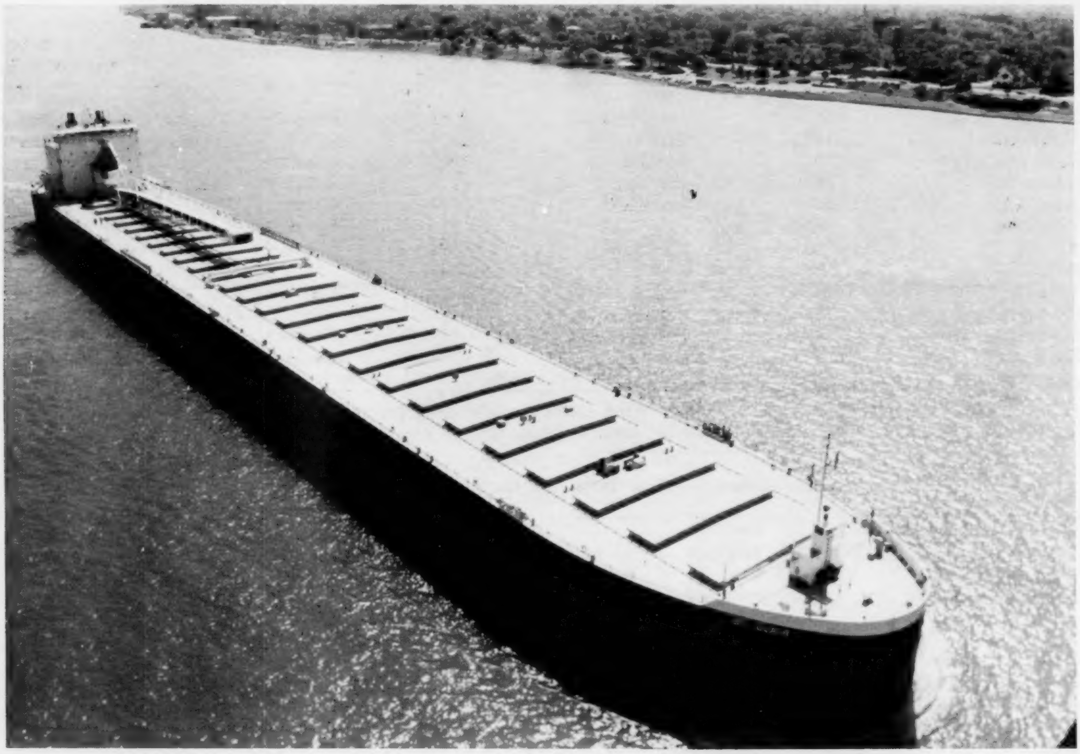


Figure 21.--The 770-ft ST. CLAIR was much lower in the water with her record load of coal. Photo courtesy of Great Lakes Commission.

frequent storms rapidly removed heat from the Lakes. An ice watch calling for ice to form in the northern Great Lakes and Green Bay was issued on December 7. The Coast Guard/NOAA Ice Navigation Center in Cleveland opened on December 10. The first icebreaking assists were performed on December 11, and the first missions using Side-Looking Airborne Radar (SLAR) were flown on December 13. The Coast Guard cutter KAW had a busy first day. She worked six domestic ships and five salties in the Detroit River. The buoy tender MARIPOSA assisted the SAGUENAY in Sandusky Bay and the BRAMBLE helped the LEADALE in Saginaw Bay. Three to 6 in of ice covered the Detroit River, but broken brash was reportedly 3 ft deep in some sections. Thicknesses of 2 to 7 in also were being observed in Lake Erie west of the Islands, in Lake St. Clair, and in parts of Saginaw Bay. In the Upper Lakes thin ice covered most of the St. Marys River, and some harbors on Lake Superior. Green Bay was covered with 8 in of ice.

The first and largest Coast Guard casualty of the ice season occurred on December 13. It was not a Friday, but it was very unlucky when the major icebreaker WESTWIND went hard aground off Detour Reef at the lower end of the St. Marys River. It took several days of lightering and hauling by Coast Guard vessels with commercial assistance to get her off. About 160,000 gal of fuel had to be off-loaded in the process. When the ship finally did ease off the reef, she slid backwards and hit the icebreaker MACKINAW, which was beside her. Because of the loss of the WESTWIND for duty in the Lakes, the Coast Guard ordered her sister ship, the NORTHWIND, from her home port of Baltimore to the Lakes for the season. Plans were also made to put the WESTWIND in drydock in Canada since no United States facility was available. The WESTWIND was not alone, however. The MARIPOSA and the OJIBWA were each lost for a week while thrust bearings and seals were replaced in mid-December. The Seaway reported the grounding of a British ship and a Liberian vessel--both in the same week. The FORT WILLIAM ran into a sand bar while working in a thick fog in western Lake Erie.

The St. Lawrence Seaway was scheduled to close for the season at midnight on December 15. However, as the deadline passed, 60 ships were still above Montreal, and the waterway remained open on a day-to-day basis to allow them to exit if possible. Very cold weather at midmonth produced large clouds of steam over the river, and navigation was halted several times because of low visibility. The seasonal removal of navigation aids, the placement of ice booms, and a shortage of pilots also contributed to delays.

EXTENDED SEASON

December 15 has traditionally marked the beginning of "extended season" navigation on the Great Lakes. The cutter KAW chalked up an interesting assist on that day. Earlier, two fishing vessels, the KAREN LEE and the SALLY ANN from Sandusky, Ohio, became trapped in ice in Lake Erie. They had been operating in shallow water close to South Bass Island--too shallow in fact for any of the Coast Guard's fleet to reach them. Several residents of the Island came to their aid, however. They got out their chainsaws and cut through 200 yd of ice so the boats could reach deeper waters. The KAW took over from there and escorted them back to home port.

The last few steelworkers' locals settled their strikes on December 17, and shippers made immediate plans to make up for lost time. The weather moderated, almost in sympathy. A storm moved through the Midwest, but this time very mild air came with it. On December 17, the thermometer soared to 60°F in Chicago--tossing out the old record of 55°F which was set in 1877. As usual, it was short lived, and colder weather with 3 to 7 in of snow fell on northern Illinois and the Lake Ontario shores of New York during the next 3 days. Winds of 40 kn and 12- to 15-ft waves on southern Lake Michigan on December 20 battered the tug AMERICAN VIKING towing two barges. One of the barges broke loose, eventually capsized and grounded with her load of scrap iron near Holland, Mich.

Daily icebreaking assistance continued on Lake Erie and the Detroit River through December. By month-end 105 direct assists had been logged by the Coast Guard. Only two of them were in the northern Lakes. The main concern was getting the "salties" or foreign ships out of the Great Lakes and the St. Lawrence River system before severe ice conditions would force the closing of the River until spring. Forces on both sides of the international boundary united in an effort to get all of the ships out. A period of mild weather the week before Christmas also contributed. The last commercial vessel to leave was the Swiss freighter ST. CERGUE. She passed through with a load of 10,000 tons of sunflower seeds on December 26. The last ship to actually transit the River was the Coast Guard icebreaker WESTWIND. She was dispatched to Montreal for shipyard repairs, arriving on December 26. The NORTHWIND arrived in Cleveland the following day.

As the New Year dawned across the Lakes, the tough ice caused the first damage to merchant vessels. The tanker JUPITER in Lake Erie and the LEON FALK JR in Superior Harbor were damaged. The most costly accident of the winter occurred on January 4, 1978. The IRVING OLDS was transiting the Livingston Channel, south of Grosse Isle, and encountered a heavy ridge of ice and stopped short. The ARMCO, directly behind her, was unable to stop and hit the OLDS. The OLDS suffered some shaft damage, and the ARMCO was damaged above the waterline near her anchor. Repairs were estimated at about a quarter of a million dollars. During midmonth four other vessels sustained ice damage in Lake Erie--the J. BURTON AYERS, LEON FALK JR., PAUL THAYER, and JUPITER. The FALK was also damaged in Lake St. Clair, and the SATURN reported damage in Lake Michigan.

Ice continued to expand from late December into January. Most of the eastern two-thirds of Lake Erie was covered with ice, although from Cleveland to the Islands, the pack remained quite loose. Thicknesses were 2 to 6 in east of the Islands and from 8 to 10 in west of the Islands. Ridging of 3 to 4 ft was reported in Pelee Passage (fig. 22). Ice around Lakes Huron and Superior remained within 5 mi of the shore. Thin ice up to 4 in and locally up to 6 in was reported on the St. Marys River and most of Whitefish Bay. Thin ice also formed in portions of the Straits of Mackinac and the harbors of Lake Michigan. In Green Bay ice thickened to almost a foot.

Very cold weather dominated the middle 2 weeks of

Figure 22.--The Coast Guard icebreaker BRAMBLE (foreground) follows the WILLIAM P. SNYDER after freeing it from the ice. United Press International Photo.

January, and snow fell frequently over the Lakes. The Chicago area had 5 to 10 in on the 14th (Cover). By the 21st seasonal record snowfalls had already been posted in Cleveland. As a result, ice thickened sufficiently to make regular icebreaking necessary on the St. Marys River by January 10. By far the worst conditions still prevailed on Lake Erie. The tanker JUPITER got stuck off Erie, Pa., on January 10. The OJIBWA set out from Buffalo to help, but she only got about 3 mi before getting beset herself in 3 to 5 ft of ridged ice. The NORTHWIND freed both ships.

The word "convoy" became more than a CB slang term by mid-January--it was the only way to move ships on Lake Erie. One convoy formed in the Detroit River and headed for Cleveland. It consisted of the CLIFFS VICTORY, JOSEPH FRANTZ, WILLIAM G. MATHER, ROBERT C. NORTON, CRISPIN OGLEBAY (fig. 23), and the J. BURTON AYERS. They managed to get to the crib just outside of Cleveland before getting beset, with the exception of the AYERS which remained in Pelee Passage. Meanwhile, another convoy of ships left Cleveland on January 15. The NORTHWIND accompanied by the MARIPOSA and BRAMBLE escorted the MCKEE SONS, LEON FALK JR., WILLIAM SNYDER, A.H. FERBERT, and the CHAMPLAIN. Strong northwesterly winds had put the ice field under strong pressure, and after 12 hr of work one ship had moved only 7,000 yd. Winds eased the following day, and the Coast Guard's determination paid off. The convoy made it through Pelee Passage--the most dangerous bottleneck--and moved steadily to Detroit.

The NORTHWIND returned to near Cleveland and spent 3 days assisting downbound ships. The most powerful of the group, the CLIFFS VICTORY, reached Cleveland on the 22d. The Coast Guard cutter OJIBWA which had been helping the major icebreaker suffered hull damage hacking through the ice and flooded her engineroom. She was towed to Cleveland. Little change in ice conditions occurred during the next 2 days (fig. 24). Food supplies ran low on the merchant

Figure 23.--The CRISPIN OGLEBAY, one of five freighters bound for Cleveland, had been trapped in Lake Erie ice for 5 days. United Press International Photo.

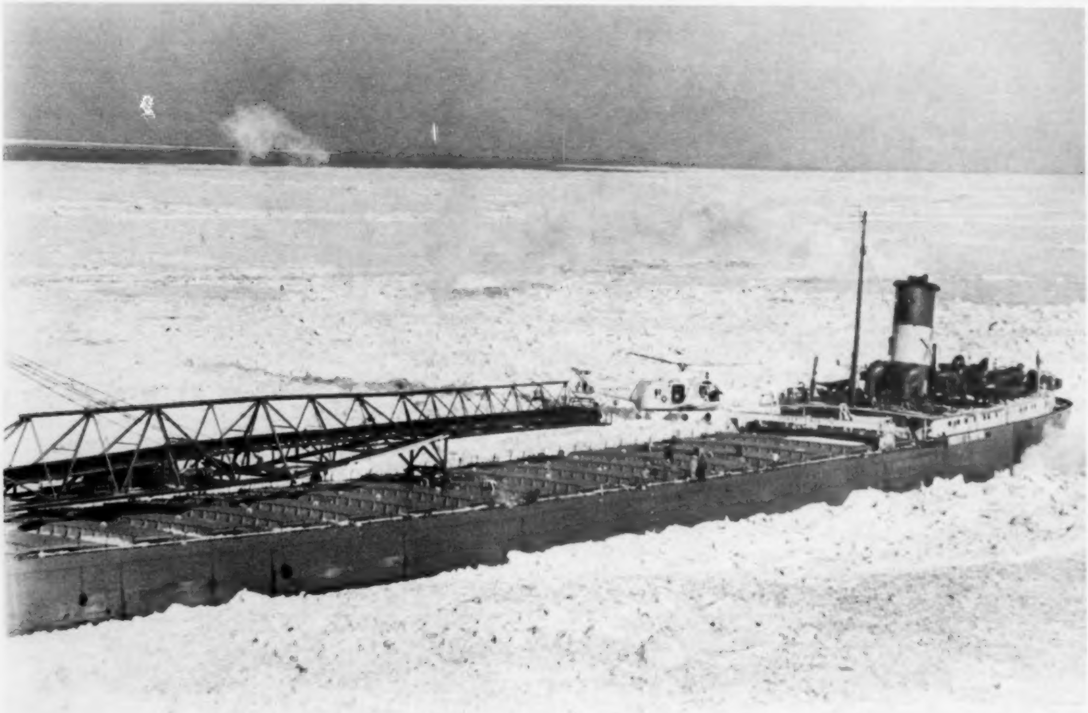


Figure 24.--A Coast Guard helicopter hovers above the ROBERT C. NORTON to pick up a crewman whose wife suffered a heart attack. A helicopter also had to fly food to the five freighters trapped for 5 days in Lake Erie ice. United Press International Photo.

vessels, and a Coast Guard helicopter delivered a fresh load. A helicopter was also called upon to transport Delmar Webster, Jr., a young seaman from the JOSEPH FRANTZ, after he was injured in a fall. Ironically, his father (Delmar Webster) was the master of the J. BURTON AYERS which was also in the convoy. After day and night struggles against the windrowed ice, the MATHER made it to Cleveland on January 24. Late the following day the FRANTZ was escorted to Cleveland, and early on the 26th the NORTON and OGLEBAY docked in Cleveland.

The NORTHWIND had proceeded to Southeast Shoal to free the AYERS when an unprecedented "white hurricane" struck Lake Erie. This storm struck suddenly and fiercely about dawn. The NORTHWIND reported 80-kn winds gusting to 90 kn at 9 a.m. The temperature was 15°F with visibility of 100 yd in snow. The AYERS was nearby and measured 98-kn winds at 7 a.m. A dock bridge in Cleveland was blown down by the icy blasts. The storm center passed northward between Cleveland and Erie, Pa. Record low pressures were established at Cleveland (28.28 in) and at both Detroit and Erie (28.34 in). Winds of over 50 kn were still reported by the NORTHWIND 12 hr later, and gales continued for another day after that. Finally, late on January 28, the AYERS was freed from Pigeon Bay and escorted to Lorain Harbor. The NORTHWIND rested briefly in Cleveland, and then departed for Sault Ste. Marie. Although there were no casualties to ships in the storm on Lake Erie, the Great Lakes Maritime Academy's training vessel ALLEGHENY (fig. 25) iced up and rolled over in the gales at Traverse City, Mich. In an unrelated incident on January 26, the CHARLES M. BEEGHLY grounded at Johnson Point on the St. Marys River. With Coast Guard assistance she moved to Detour for lightering. Damage was estimated at $160,000.

By the end of January ice expanded out from the shorelines of Lakes Michigan, Superior, and Huron to about 10 mi on the average and up to 10 in in thickness. The southern third of Lake Huron was mostly ice covered with thin ice. Ice across the Straits expanded southward to Little Traverse Bay and eastward to near Bois Blanc Island. The ice was almost a foot thick in some spots. St. Marys River was solidly frozen, as was Whitefish Bay. Nearly 30 in of brash ice was reported in the river track. Elsewhere, 4 to 8 in of ice was common. The worst ice conditions continued to be observed on Lake Erie, with rafting up to 12 ft in the Colchester Reef area and from 2 to 6 ft off Cleveland. Drift ice was limited to the midlake area from the Islands to near Ashtabula and from the Canadian shore to within about 10 mi of the U.S. shoreline.

Traffic gradually dwindled during the month. About 4 doz ships were still operating at the beginning of

Figure 25.--The training vessel ALLEGHENY rests on her side in Traverse Bay after tons of ice capsized her. The ice built up from spray blowing on the 900-ton ship and freezing during blizzard conditions. United Press International Photo.

January, but less than half of them were operating by monthend. The main problem area outside of Lake Erie was the St. Marys River. High-water flows through the Soo Canal from Lake Superior appeared to be causing unusually large accumulations of ice along the water's edge, where engineers measured ice up to 15 ft thick. Because of one-way traffic procedures in the River when the West Neebish is closed during the winter, 26 vessels were awaiting transit on January 20. With the addition of the NORTHWIND and the Canadian icebreaker GRIFFON to the forces in the River, the backlog was cleared by the end of the month.

February was the frigid month on the Lakes for this season (fig.26). Departures were comparable to January of the previous season. Temperatures were consistently cold throughout the month, except in western Lake Superior during the last week. A departure of -11.6°F on Lake Erie for the month was the greatest for any lake this season. Ice cover continued to expand and became more stable because of the very cold conditions. Shipping continued to gradually withdraw. By the end of the month traffic was reduced to six ore vessels, one tanker, a few tug-and-barge combinations, and two Canadian vessels. The last traffic into upper Green Bay at Little Bay De Noc was on February 22, when the WILFRED SYKES loaded ore pellets.

Figure 26.--On February 8 only Lake Erie is completely frozen. The other Lakes have ice in bays along the shore.

Figure 27.--The VHRR NOAA satellite image of March 6 shows the Lakes almost cloud free. The ice on Lakes Huron and Superior has increased vastly.

Temperature records fell several times during February. On the 4th old marks were exceeded with -24°F at Alpena, -16°F at Traverse City, -12°F at Erie, and -9°F at Muskegon. Toledo also broke low-temperature records with -9°F on the 21st, and several Michigan cities shivered in record cold the next morning. Slightly milder air spread into the Lower Lakes region on the last few days of the month. Temperatures at Detroit and Cleveland rose to the freezing mark for the first time in over a month. This brief respite prevented these cities from having their coldest February ever. Snowfall continued to be plentiful. A dusting of snow on February 23 in Chicago pushed their season total to an all-time high of 77 in.

The most dramatic changes in ice cover were observed on Lakes Superior and Huron. By monthend (fig. 27) Lake Huron was 90 percent ice covered, with the only open water along the extreme northern end and drift ice along the shore from Tawas to Alpena. Thicknesses ranged from 8 to 14 in with 1- to 2-ft rafting along the Canadian shore. Ice on Lake Superior had grown outward and covered 85 percent of the lake. Open water at monthend was in an 80-mi-diameter circle off of Grand Marais, Mich. Drift ice was concentrated west and north of the open water to the Keweenaw Peninsula, along the Minnesota shoreline, and southeast of Isle Royale. The ice was generally less than 8 in thick outside of bays and harbors. One- to 3-ft rafting was reported in Whitefish Bay. Ice up to a foot covered all of the Straits with ridging up to 3 ft. From the Straits, ice continued down the eastern shore of Lake Michigan out to about 15 mi, around the southern end, and up the western shore to near Kenosha. Lake Erie, Lake St. Clair, and all three of the major river systems were 100 percent ice covered. Rafting up to 8 ft was still reported on Lake Erie.

In spite of the decline in ship traffic during the month, icebreaking continued. The Coast Guard logged over 150 direct icebreaking assists. Most of these were in the St. Marys River, where continuous assistance was necessary to transit the area. Only a few requests for Coast Guard assistance were made in Green Bay this season because commercial assistance was available. Two U.S. Steel ships reported damage during the month. The PRESQUE ISLE was damaged on the 21st, and $40,000 damage was caused by a collision between the JOHN G. MUNSON and the NORTHWIND. The Coast Guard lost the services of the KAW on February 13 because of hull cracks and rudder damage.

SPRING OPENING

Cold weather continued into March. Temperatures averaged below normal for all the Lakes, but periodic milder spells were more numerous. On March 9, for example, the temperature plunged to -11°F at Lansing, Mich.--12° below the former record; yet by afternoon the thermometer edged up to 33°F, shooting past the freezing mark for the first time in 59 days. Alpena, Mich., also shrugged off the cold and hit the 50's. Maximum freezing-degree days (a good measure of the peak of the ice season) were reached in mid-March, except in late March for Lake Superior and in early April at Sault Ste. Marie. Most of the dates were within a few days of the normal peaks. All stations but Marquette accumulated more than the normal number--another indication of the severity of the winter season.

During the first week of March ice expanded on Lake Superior to cover most of the open water in the eastern sections. Drift ice in Lake Michigan spread over all of the lake's northern half. Some ice growth was also reported in other areas. Milder weather at midmonth, however, began to change conditions. On Lake Huron a large lead from Alpena to Tawas expanded and about a third of the lake was open by the 15th. By monthend only drift ice remained south of the thumb and along the eastern third of the lake to the entrance to Georgian

Figure 28.--On March 24 high pressure keeps the Great Lakes clear, while a large LOW is centered over the juncture of the Mississippi and Ohio Rivers. It is still very cold north of the Lakes with Hudson Bay still frozen solid.

Bay. On Lake Superior by midmonth solid ice cover decreased to pack ice, except west of the Keweenaw through the Apostle Islands. The only ice left at the end of the month was confined to bays, harbors, and along the southern and eastern shores (fig. 28). Ice on Lake Michigan remained only in the Straits and in Green Bay, with some cakes and small floes in the southern end. On Lake Erie ice deteriorated from Cleveland westward to the Islands and loosened from the Islands to within 50 mi of Buffalo by March 31. Lake St. Clair was only 70 percent ice covered.

Improved sailing conditions brought an equal increase in traffic. The BLOUGH resumed ore shipping to Lake Erie with a 45,000-ton load of pellets to Conneaut on March 23. The JOHN G. MUNSON arrived in Lorain the next day. Heavy snowmelt in northern Ohio caused some flooding problems along Lake Erie. A number of Coast Guard ships were dispatched to harbors from Vermillion to Ashtabula from March 16 to 21 to break up ice at river mouths. No heavy rains accompanied the snowmelt, so serious flooding threats ended by monthend. About 45 commercial vessels were sailing by March 31.

The St. Lawrence Seaway officially opened on schedule in early April. On the 3d the French vessel HERMINE entered the Montreal-Lake Ontario section upbound. The first downbound ship was the J. N. MCWATTERS. The Welland opening on March 30 saw the TARANTAU pass through. Ice on parts of the Seaway ranged from 30 to 36 in deep at the opening, but forces in both Canada and the United States worked to keep the track open.

Ice in almost all areas of the Lakes gradually disappeared during April in spite of below-normal temperatures. At the end of the month ice remained packed in extreme eastern Lake Erie, where "Operation Open Buffalo" went into effect on March 27 (fig. 29). It was also packed on the North Channel of Lake Huron, in parts of the lower St. Marys River, outside the track lines of Whitefish Bay, and in some of the northern harbors of Lake Superior.

As usual, the hard spring ice took its toll of ships. The MUNSON sustained about $40,000 worth of rudder damage in Whitefish Bay on March 27. On April 20 the BUCKEYE sustained $30,000 damage while operating in the St. Marys River. Nine other vessels reported much smaller amounts of damage to the Coast Guard during the remainder of April. The number of operating ships jumped to about 75 during the first week. The Arctic icebreaker WESTWIND returned to the Lakes from Montreal when the Seaway opened, allowing the NORTHWIND to head back to Baltimore on April 7. The Coast Guard C-130B SLAR aircraft made routine flights until midmonth and then returned to her home base in Florida. The plane spent 335 hr on ice patrol in the Lakes for the season.

Ice gradually disappeared in the remaining waterways in May. The Coast Guard continued to do some preventative icebreaking in the St. Marys River during the first few days of the month. Ice at the eastern end of Lake Erie was about the last to go. The OJIBWA had the honors of performing the last assistance of the season for the GEORGE M. CARL. "Operation Open Buffalo" terminated on May 15.

SUMMARY

For the second consecutive year, severe winter weather created very heavy ice conditions on the Great Lakes. November was mild, but without exception, the remaining 5 mo were colder than normal throughout the Lakes. Because of a strike at mines and processing plants, fall shipping was delayed until winter. A total of 125 ships representing 32 companies, plus 5 foreign "salties," and 8 fishing vessels participated in extended-season operations. Foreign shipping set a new record for the St. Lawrence Seaway. The increased tonnage coupled with an early winter created massive traffic tie-ups in the river system in December. The last vessels did not reach the Atlantic until after Christmas--the latest the Seaway has ever been open. In spite of the severe midwinter conditions, shipping continued without interruption on the Upper Lakes.

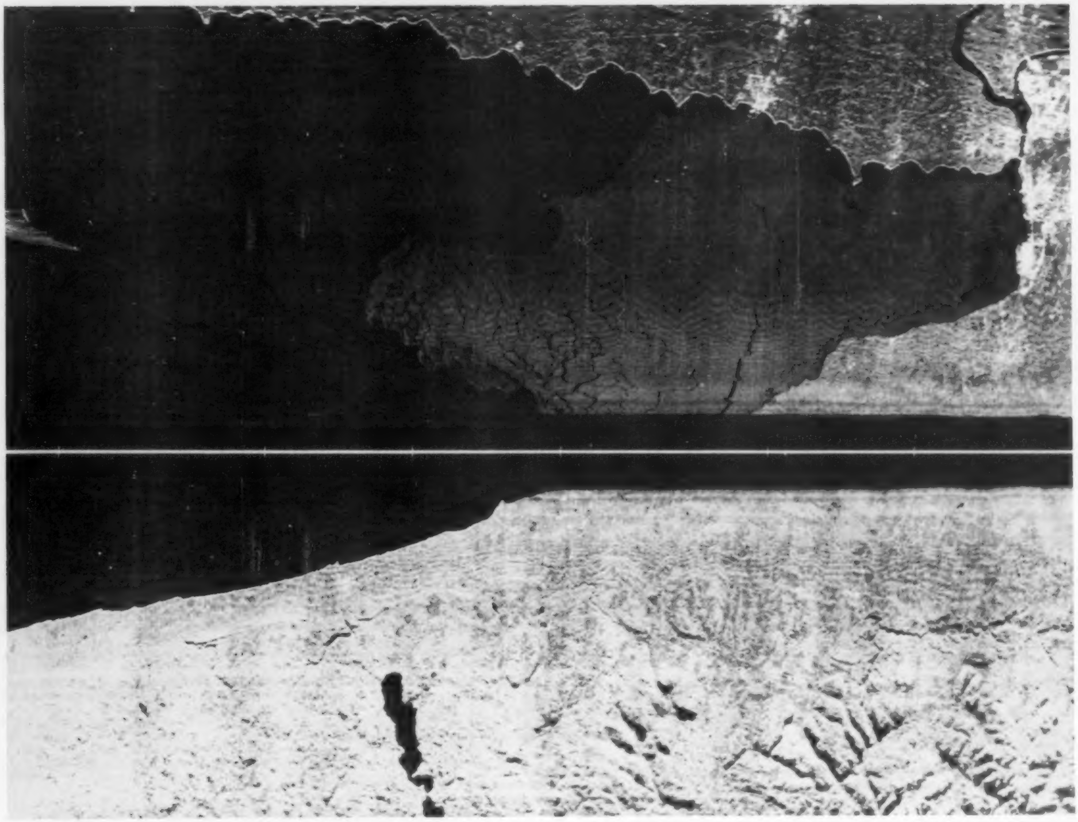


Figure 29.--This SLAR image shows the ice pack at the eastern end of Lake Erie. Buffalo, N.Y., is at the extreme upper right with the Welland Canal to the west. The four white dots in the ice southwest of the canal are ships out of the canal.

Demands placed upon Coast Guard icebreakers because of the ice and heavier-than-usual traffic were the greatest ever. Total cargo tonnage assisted was more than double that of the previous season. It was a year of challenge for all involved, but a year that was met with determination and dedication. It was yet another landmark year in Great Lakes ice history.

ACKNOWLEDGMENTS

Icebreaking data and casualty information were supplied by the Ninth Coast Guard District, Cleveland, Ohio. Ice information was derived from records of the National Weather Service Forecast Office, Ann Arbor, Mich., and the Ice Navigation Center, Cleveland, Ohio. Additional information was obtained from the Center for Archival Collections at Bowling Green, Ohio.

Hints to the Observer — Tips to the Radio Officer

RESULTS OF WMO WEATHER REPORT TRANSMISSION QUESTIONNAIRE

The following letter from the Secretary-General of the World Meteorological Organization concerns the replies to the questionnaire on transmitting ships' weather reports of May 1977. Annex I concerns the salient points which emerged from that inquiry. Annex II is a note on the voluntary observing ships' scheme.

Note the announcement on page 416 of a new questionnaire from the WMO concerning marine weather services.

ORGANISATION MÉTÉOROLOGIQUE MONDIALE — WORLD METEOROLOGICAL ORGANIZATION

SECRÉTARIAT
GENÈVE - Suisse

Téléphone : 34 64 00
Télégrammes : METEOMOND GENÈVE

Telex : 23 260
Case postale N° 5
CH-1211 Genève 20

GENEVA, 15 August 1978

Circular letter addressed to captains of ships participating in the WMO Voluntary Observing Ships' Scheme

Dear Captain,

You may recall that in May 1977 I addressed a letter to you and other ships' captains concerned enclosing a questionnaire regarding difficulties encountered in transmitting ships' weather reports to coastal radio stations. It is very gratifying to report that over 1000 replies were received which clearly revealed that ships' personnel, particularly navigation and radio officers, were very willing to assist the World Meteorological Organization in its efforts to bring about improvements in the facilities and procedures used for the transmission and reception of ships' weather reports.

Many of the replies confirmed some long-suspected deficiencies in ship-to-shore telecommunication arrangements whilst others identified new areas of concern; still others highlighted specific points regarding the performance of individual coastal radio stations. Because of the interest and concern which the inquiry revealed, I feel sure you will be interested to know in what ways the wealth of information received has been utilized.

Initially, two preliminary analyses of the replies were made (in October and November 1977) for the consideration of two WMO bodies concerned with the transmission and reception of ships' weather reports. Later, when all the replies had been received (this was in February 1978) the 2,800 comments and suggestions made were analysed and a comprehensive report was prepared. This report was then circulated to all Members of the Organization with a request that remedial action by appropriate national authorities be taken as far as possible.

I now have pleasure in enclosing for your own information a broad analysis of the salient points which emerged from the inquiry (Annex I). Even if you do not recognize the precise wording of your own remarks in this analysis, you may be assured that they have been taken into account in the study.

Before closing I should like to mention that the WMO voluntary observing ships' scheme has benefited greatly from your co-operation in the provision of ships' weather reports. A note on this scheme, which also demonstrates the value of ships' weather observations both to the meteorologist and to the mariner himself, is attached hereto as Annex II to this letter; I trust you will find it interesting. That this interdependence between the mariner and the meteorologist can be strengthened by means of a direct dialogue has been amply demonstrated by your response to the inquiry. I should therefore like to invite you to bring to the attention of either the WMO Secretariat or your national Meteorological Service, any further areas of concern in the existing ships' weather report collection system.

On behalf of the World Meteorological Organization, I should like to thank you once again for your valuable co-operation.

Yours sincerely,

(D.A. Davies)
Secretary-General

Annex I

Salient points from inquiry regarding ship-shore telecommunications

(Reference WMO circular letter PR-2776 of 23 May 1977)

From the total of over 1,000 completed questionnaires, approximately 24 per cent indicated satisfaction with the existing system and 13 per cent indicated "no comments". The remainder fell mainly within the following broad categories:

(i) Non-adherence to declared watchkeeping hours and frequencies

Many replies indicated that certain coastal radio stations were not keeping watch nor operating on the frequencies published in Volume D.

(ii) Expansion of HF facilities at coastal radio stations

A strong requirement was expressed for the expansion of HF facilities particularly at coastal radio stations along the west and east coasts of Africa, the Indian Ocean in general and the west coast of South America; MF communications have a very limited range and are sensitive to static and therefore of little use for the collection of SHIP reports.

(iii) Allocation of special frequencies and time slots for the reception of OBS messages

Many replies expressed appreciation for arrangements made by some countries whereby special frequencies and time slots are reserved exclusively for the reception of OBS messages and expressed the hope that systems, similar to those in operation at Japanese and U.S. Coastguard coastal radio stations might be adopted at other coastal radio stations. This arrangement was considered well justified in view of the priority accorded to OBS messages which are brief in comparison with most other traffic.

(iv) OBS priority

A large number of coastal radio stations were accused of ignoring the OBS priority specified in ITU Radio Regulation 37A.

(v) Modifying OBS preamble

Many replies indicated that a modified preamble would expedite the transmission of ships' weather reports.

(vi) Insufficient areal coverage of coastal radio stations designated for the reception of ships' weather reports

This problem was found to be particularly acute in WMO Regions I II, III and V.

(vii) Utilization of other national coastal radio facilities

To augment the capacity of the existing system it was proposed that the expanded use of coastguard stations, maritime safety agencies or naval coastal radio stations be considered.

(viii) Use of other communication modes such as satellites and radiotelex

(ix) Clash between meteorological broadcasts and OBS transmission times at main synoptic hours

(x) Selection of coastal radio stations

It was apparent that a number of ships' radio officers are unaware of alternative procedures allowed in WMO regulations for the transmission of OBS messages to coastal radio stations.

(xi) Value of late reports

It was apparent that a number of ships' radio officers think it pointless to transmit late reports.

With regard to (i) to (vi) above, Members of WMO have been requested to take action with their national telecommunication administrations. As regard (vii) to (ix) above Members of WMO have been requested to investigate these matters and take appropriate action: (x) and (xi) can best be covered by quoting hereunder the appropriate sections from the WMO Manual on the Global Telecommunication System:

2. *Transmission of ships' weather reports to coastal radio stations*

2.1 Weather reports from mobile ship stations should be transmitted to a coastal radio station as soon as possible after the time of observation.

2.2 Weather reports from mobile ship stations should (without special request) be transmitted from the ship to the nearest coastal radio station situated in the zone in which the ship is navigating.

2.3 If it is difficult, due to radio propagation conditions or other circumstances, to contact promptly the nearest coastal radio station in the zone in which the ship is navigating, the weather messages should be cleared by applying the following procedures in the order given below:

(*a*) Transmission to any other coastal radio station in the zone in which the ship is navigating;

(*b*) Transmission to any coastal radio station in an adjacent zone within the same Region;

(*c*) Transmission to any coastal radio station in any other zone within the same Region;

(*d*) Transmission to a coastal radio station in an adjacent zone in a neighbouring Region or, failing that, to any other station in a neighbouring Region;

(*e*) Transmission to another ship or an ocean weather station with the function or willing to act as a relay station.

4.3 Observations made at any of the standard times 0000, 0600, 1200 and 1800 GMT should be transmitted even after a period of delay after the time of observation and:

(*a*) In most parts of the world they should be transmitted up to 12 hours after the time of observation if it is not possible to do so earlier;

(*b*) In the southern hemisphere and other areas where few ships' weather reports are available, they should be transmitted up to 24 hours after the time of observation.

It is important that this procedure be followed even if an observation for a more recent time is also being transmitted.

In connexion with paragraph 4.3 above, Members have been requested to make arrangements for the reception by coastal radio stations of <u>all</u> available ships' reports including those which are 12 hours old and in data-sparse areas up to 24 hours old.

ANNEX II

NOTE ON THE WMO VOLUNTARY OBSERVING SHIPS' SCHEME

The WMO voluntary observing ships' scheme is based on long-standing co-operation between mariners and meteorologists in the acquisition of meteorological observations from ocean areas. In fact, international arrangements to obtain weather information from ocean areas were first discussed at an international conference in 1853. Since that time, developments in instrumental and communication techniques, particularly the advent of radio, have allowed the original arrangements to be improved and expanded. The result today is that there are now more than 7,000 ships from at least 40 different countries, both developed and developing, taking part in what is now known as the WMO voluntary observing ships' scheme.

The WMO voluntary observing ships' scheme constitutes an important component of a WMO system known as the Global Observing System of the World Weather Watch to study global meteorological processes. The main objective of the WMO voluntary observing ships' scheme is to provide, at standard times, basic marine observational data from the world's oceans. Ships' weather reports received through coastal radio stations are relayed to national meteorological Centres where the reports are inserted onto an exclusive and world-wide meteorological telecommunication circuit which is called the Global Telecommunication System of the World Weather Watch. This very modern and expeditious system of data exchange permits weather forecasting centres to issue timely forecasts and warnings to shipping on the major ocean basins of the world. In recent years the installation of radio facsimile receiving equipment aboard many ships permits the captains of these ships to have at their disposal weather charts covering large sea areas of interest to them. Thus they are able to interpret more accurately the analyses and forecasts issued by Meteorological Services.

It is important to bear in mind that, for the voluntary observing ships' scheme to function at the required level of efficiency, sea areas of interest to national forecasting centres should be covered by an adequate number of accurate ships' weather reports. Inaccurate observations, especially when coming from data-sparse sea areas, not only mislead the forecaster but, when used for climatological purposes such as the compilation of marine atlases and for scientific investigations, may bias the computations and tend to falsify the picture.

Observers at sea would perhaps be surprised at the many uses to which their observations are put, both commercially and scientifically. To mention only a few: frequencies of winds of gale force are required whenever the loadline criteria are reviewed; air temperatures and humidities have been useful in the testing of life jackets; meteorological data are needed by the respective research organizations in connexion with the design of ships and with the efficiency of radar.

Thus, by taking an intelligent interest in meteorological observations, the seaman contributes to the science and practice of meteorology from which the world in general and his fellow seamen in particular benefits through an increase of our knowledge of meteorology and climatology. In spite of the capabilities of meteorological satellites and other remote-sensing techniques for the acquisition of marine environmental data, voluntary observing ships will constitute the main source of marine meteorological information from the oceans for many years to come.

The counterpart to this voluntary assistance, namely, providing meteorological information to shipping, fisheries and other marine user groups is a subject to which WMO, through its Commission for Marine Meteorology and its Commission for Basic Systems, has devoted increased attention in the past decade. Surveys of user requirements for specialized marine meteorological services are conducted from time to time and, as a result, services can be provided to meet specific needs.

NEW PROCEDURES FOR LOOP CURRENT MESSAGE

Beginning November 15, 1978, the Gulf of Mexico Loop Current message will be available on Western Union Telegraph Company's FYI system. Anyone with access to a Western Union TWX or TELEX terminal can obtain this message using these procedures:

1. TELEX users dial 8513. TWX users dial 710-988-5956.

2. Pause for exchange of answerbacks.

3. Type GULF.

4. The Western Union FYI system will then send the message.

The Loop Current message is prepared three times a week on Monday, Wednesday, and Friday during the period November 15 to May 15. The message may be obtained 24 hr a day through the Western Union FYI system and will cost about $4.00 for ships at sea and $.50 for users on land.

The Loop Current flows north through the Yucatan Channel and makes a clockwise loop around the eastern Gulf of Mexico before flowing out through the Florida Straits and joining the Gulf Stream. Ships transiting the Gulf and commercial fishermen have long used this current to their advantage. The thermal gradient associated with this warm current is montiored by the Miami Satellite Field Services Station using infrared imagery from GOES geostationary and polar-orbiting satellites. The thermal contrast between the Loop Current and surrounding Gulf water is negligible during the summer and not detectible from satellite infrared data; therefore, the message is not prepared during the summer months.

Below is a sample Loop Current message.

GULF OF MEXICO LOOP CURRENT 15 NOVEMBER 1978
CODED POINTS GIVE LATITUDE/LONGITUDE ALG THE CSTWD EDGE OF THE WARMER WATER

222869 234871 248876 255872 262879 250885 248888 255892 260899 275880 274872 263862 263852 253842 235848 240838 244835 237826 236820 240814

MAX CURRENT LIES APPROX 14 KM SOUTH AND EAST OF THIS LINE EAST OF 87.6W

WEAK WARM EDDY EXTENDS N IN EAST GULF BTWN 26.5N TO 28.4N FROM 85 TO 86W

NESS/NWS VIA WESTERN UNION

NEW EDITION OF SHIPS WEATHER RADIO STATIONS DISTRIBUTED

The July 1978 edition of the publication <u>Radio Stations Accepting Ships' Weather and Oceanographic Observations</u> has been distributed to participants in the Cooperative Ship Program. Additional copies are available from Port Meteorological Officers.

ACKNOWLEDGMENTS

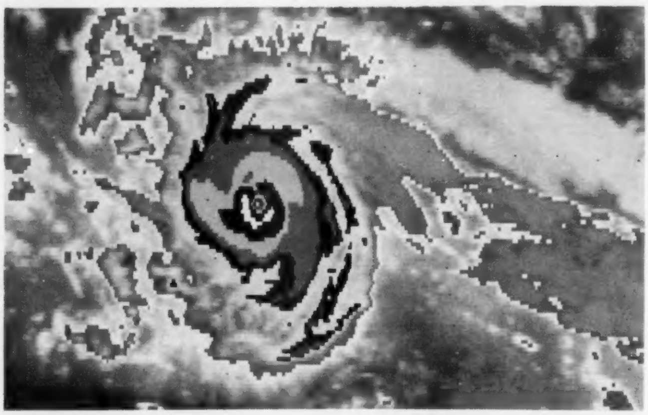
Thanks to R/O Pekka Husgafvel, M/V FINN-ENSO, for recent information relative to the marine weather program.

Hurricane Alley

Dick DeAngelis
Environmental Data and Information Service, NOAA
Washington, D. C.

HAVE YOU SEEN THIS STORM?

WANTED: TROPICAL CYCLONE CORA



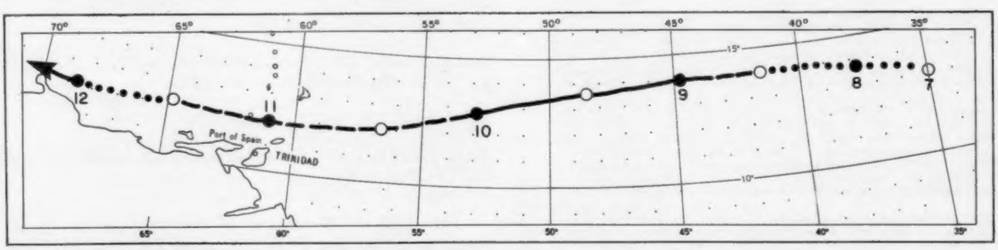
For: INVESTIGATION

Aliases: hurricane Cora, tropical storm Cora

Description:
small, intense North Atlantic storm; maximum winds estimated at 80 kn late on August 8, 1978.

Violation:
suspected of hurricane activity, but slipped through tropical waters apparently unobserved by merchant fleet.

satellite tracked suspect from northwest Africa across North Atlantic. Last seen off Aruba on August 12. Satellite photographs indicate Cora involved in hurricane activities from the 8th to the 10th. Authorities looking for confirmation of this activity. Any ships in the general area during this period, please contact: Charles J. Neumann, c/o National Hurricane Center, P.O. Box 8286, Coral Gables, FL 33124



SEARCH FOR INFORMATION ON CORA

So far in this case two witnesses to the hurricane have turned up. Unfortunately, neither was very close to the center of activity. The PERK encountered 20-kn winds more than 150 mi north of the center at 1200 on August 9, while the MORMACALTAIR reported similar windspeeds some 250 mi south of the storm some 6 hr later. Witnesses closer to the action are being sought as indicated in the poster above. The satellite photograph in the poster is an enhanced infrared taken at 2101 on the 8th.

NORTH INDIAN OCEAN
MAY 1978

In my last column there was mention of a May depression in the Bay of Bengal. This depression turned out to be a well-developed tropical storm (18-78) as was first determined by the National Environmental

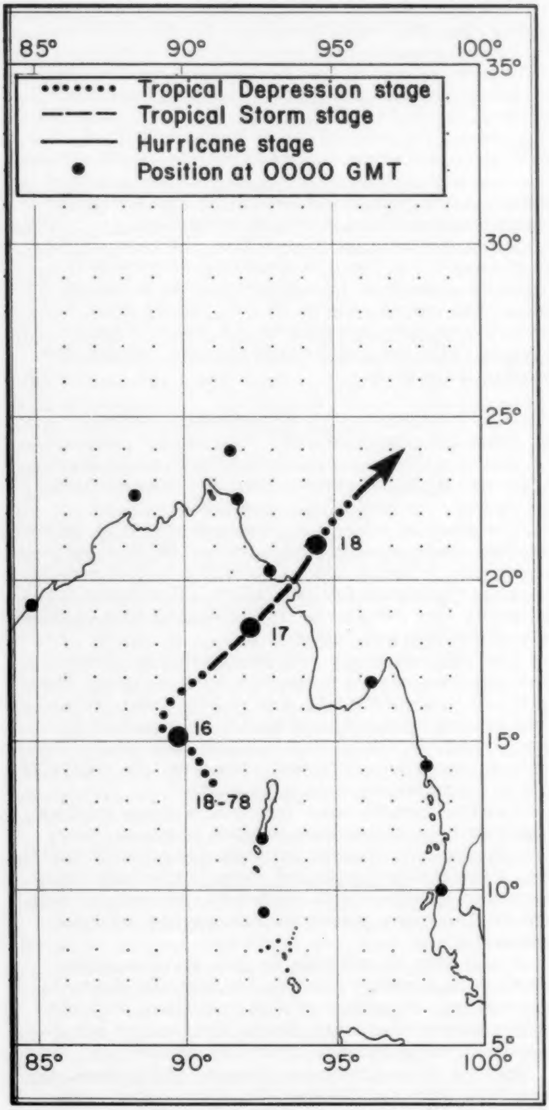


Figure 30.--Track of tropical cyclone 18-78.

Satellite Service. On the 15th a depression was discovered to the northwest of the Andaman Islands (fig. 30). After traveling northwestward for a day, the depression recurved and headed toward Burma. Maximum winds climbed to near 50 kn early on the 17th. Later in the day the storm moved inland just south of Akyab. Near the center the town of Kyaukpyu suffered extensive damage.

NORTH INDIAN OCEAN AND SOUTHERN HEMISPHERE JULY AND AUGUST 1978

No activity was noted in any of these basins during the 2-mo period. This is not unusual as it is midwinter in the Southern Hemisphere, and the southwest monsoon dominates the North Indian Ocean.

1965 GLOBAL TROPICAL-CYCLONE ACTIVITY

The global tropical-cyclone highlights of 1965 included a record 11 supertyphoons (winds of 130 kn or more) in the western North Pacific and the North Atlantic's record damage-producing hurricane Betsy. Overall global totals were six below the 1965-77 normals of 81 tropical cyclones (winds $\geq$ 34 kn) and 42 hurricanes (winds $\geq$ 64 kn). This deficiency was most noticeable in the Southern Hemisphere. The Northern Hemisphere was prevented from dropping below normal by an active year in the western North Pacific--a year which saw at least one tropical cyclone in every month. The two least active basins, based on normals, were the eastern North Pacific and the Australia-South Pacific region. Tropical-cyclone activity in February and June was well above normal, while July and October were considerably less active than usual. Table 7 summarizes the year.

Table 7.--Global tropical-cyclone activity originating in 1965

Month	North Atlantic	Eastern North Pacific	Western North Pacific	North Indian	South Indian	Australia S. Pacific region	Total
January			2 (1)		2 (1)	3	7 (2)
February			2		4	3 (3)	9 (3)
March			1			2 (2)	3 (2)
April			1 (1)		1		2 (1)
May			2 (2)	2 (1)			4 (3)
June	1	4	3 (2)				8 (2)
July			5 (4)				5 (4)
August	2 (2)	3 (1)	6 (3)				11 (6)
September	2 (1)	3	7 (5)				12 (6)
October	1 (1)		2 (2)				3 (3)
November			2 (1)	1			3 (1)
December			1	3 (1)	2	2 (2)	8 (3)
Total	6 (4)	10 (1)	34(21)	6 (2)	9 (1)	10 (7)	75(36)

Note: The number in parenthesis indicates the number of storms which reached hurricane intensity.

On the Editor's Desk

ALARM SYSTEM TO WARN OF STEERING GEAR FAILURE

A system has been designed that rings an alarm and flashes a light in a ship's wheelhouse just seconds after a steering gear failure occurs. Called the "Steering Failure Alarm," the system is intended to prevent groundings and collisions attributable to steering gear failure, an important cause of ship accidents.

The system will be installed on nine liquefied natural gas (LNG) carriers being built in the United States and France. In addition, a system has been ordered for an oil tanker.

The Steering Failure Alarm contains patented circuits which respond almost instantaneously to a discrepancy between the rudder's actual position and the position which is indicated by a computer simulation. If the discrepancy is greater than a preset value, the system sounds an alarm within 2 or 3 s.

The system is independent of the ship's steering control system. It uses two basic signals--rudder order and rudder angle--provided by separate transducers on the helm and rudder. If the ship already has a separate rudder angle indicator system, it can be used to provide the rudder angle signal. With automatic steering, the autopilot computer output is used as the rudder order signal.

The U.S. Coast Guard is currently studying proposals to require a steering failure alarm system on all ships over 20,000 tons operating in U.S. waters.

NEW PMO AT NEDERLAND, TEXAS

Peter B. Connors has assumed responsibilities as the new Port Meteorological Officer for the National Weather Service in the Beaumont-Port Arthur, Tex., area (fig. 31).

A seagoing veteran of 20 yr service with the Weather Service and the Environmental Research Laboratories, Mr. Connors was most recently assigned to the Sea-Air Interaction Laboratory at NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla.

He has participated in meteorological expeditions that have taken him from the Antarctic aboard the ELTANIN to the Northwest Territories of Canada. He served aboard ocean station vessels as a member of the Atlantic Weather Project. He has sailed aboard NOAA's research vessels OCEANOGRAPHER, RESEARCHER, and VIRGINIA KEY and supported meteorological and oceanographic activities in such international field experiments as ATEX, BOMEX, GATE, FGGE, and the Indian Ocean Expedition.

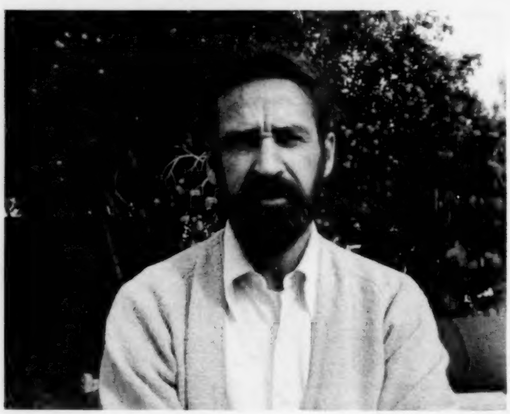


Figure 31.--Meet Peter B. Connors, the new PMO at Nederland, Tex.

EARTHQUAKE AND CRUST MONITOR

The National Science Foundation recently announced a plan to monitor earthquakes and study the Earth's crust by installing a seismic device in a hole drilled 450 m below the ocean floor.

The device, if successful, could be the start of a network of similar instruments placed at scattered undersea sites throughout the world. At present, there is a large land network of such devices called the Worldwide Seismic Net; the undersea project would be an extension of this network, giving scientists a type and quality of data not possible before.

The hole is scheduled to be drilled in November 1978 by the GLOMAR CHALLENGER. The device, an instrument package containing sensors and electronics, is the first of its kind to be placed under the sea floor. The hole will be drilled at a depth of 1,200 m at the mouth of the Gulf of California, a site chosen because it is a small ocean basin being formed by a rifting of continental crust of the peninsula of Baja California away from the mainland of Mexico.

The instrument package will be 10.1 cm in diameter and 4.5 m long, an adaptation of seismic devices that have been placed on the ocean bottom in the past. The instruments in the hole will be wired to a recorder on the ocean bottom; the recorder can be brought to the surface for data recovery without disrupting the sensors.

NEW ENVIRONMENTAL SPACECRAFT SERIES

NASA launched TIROS-N, the first in a series of new operational meteorological monitoring satellites--the TIROS-N series--from the Western Test Range near Lompoc, Calif., on October 13.

The first of eight in a third generation of polar-orbiting environmental spacecraft, TIROS-N will carry new environmental monitoring instruments into space that should provide significant technological advances over those on board the current NOAA series spacecraft they will replace.

The TIROS-N series will be operated by NOAA's National Environmental Satellite Service (NESS). Support will be provided by a data retrieval and processing system especially designed to help meteorologists, oceanographers, hydrologists, and other scientists to maintain--and perhaps improve--the quality of life on an increasingly complex Earth.

Potential benefits are: improved weather analysis, resulting in more accurate weather forecasts; more specific location of ocean currents and areas of upwelling, important to fishing and shipping interests; and more precise snowcover, snowmelt, and rainfall data, essential to water resources management and flood forecasting.

It will also be possible to give more accurate alerts of high energy solar radiation levels above the atmosphere, of concern to space missions, high altitude commercial aircraft flights, long-range communications, and electrical power distribution networks.

For the first time ever, because of its advanced data collection and platform location system, the TIROS-N series spacecraft will provide an operational capability to collect and transmit environmental data from platforms on land, at sea, and airborne, and also determine the geographic locations of those platforms when they are in motion on the sea or land surface or aloft.

The sensors are multi-National in character. Each spacecraft will carry a stratospheric sounding unit from Great Britain and a data collection and platform location system from France, while the other sensors were developed in the United States.

It is the TIROS-N series sensors--and the systems on the ground that communicate, process, and deliver the final products to the ultimate users--that are of greatest significance. The scanning radiometer on board, for example, is the most versatile yet carried

aboard an environmental satellite. It is designed to gather, and store for later playback, visible and infrared measurements and images in four channels.

This will permit more precise evaluation of land, ice, surface water, cloud conditions, and sea-surface temperatures, while also transmitting in realtime to both Automatic Picture Transmission (APT) and High Resolution Picture Transmission (HRPT) users located in more than 100 countries around the world.

Similarly, the vertical sounder subsystem, consisting of three instruments, should give improved temperatures to within 1°C and moisture data from the surface of the Earth up through the stratosphere. Even in the presence of obscuring cloud cover, some data are recovered, since one of the three instruments can detect microwave radiation unaffected by most clouds.

The ground support systems are multi-National also. The United States will handle acquisition and processing of most of the data through NOAA Command and Data Acquisition (CDA) stations near Fairbanks, Alaska, and Wallops Island, Va., and a central processing system at Suitland, Md. But the Centre National d'Etudes Spatiales (CNES) of France will be responsible for the processing and distribution associated with the data collection and platform location system. And, the French Meteorological Service will operate a special readout station in Lannion, France, to gather atmospheric temperature data from the satellite during orbits not visible in the United States.

The TIROS-N system will be a primary source of data for the First GARP Global Experiment (FGGE), an international cooperative project involving some 140 countries and scheduled to begin on December 1, 1978. Its instrumentation payload is designed to meet FGGE requirements for quantitative data of the Earth's atmosphere and sea surface essential to the solution of atmospheric numerical models for improved long-range weather forecasts.

The TIROS-N operational system benefits from the experience of designing NASA's original TIROS (Television Infrared Observation Satellite) series of 10 research satellites which began with TIROS-1 in 1960. This series spacecraft went through a number of evolutionary stages until NOAA was satisfied that the spacecraft was ready to go operational and proceeded to fund its own series.

In 1966 its first NOAA Operational Satellite was launched, followed by eight more. The improved TIROS Operational Satellites (ITOS), with advances in research and development, were funded and launched by NASA in 1970-71, and then five similar NOAA-funded satellites were launched from 1970 to present.

NOAA STUDY LINKS SOLAR FLARES AND ATMOSPHERIC ELECTRICITY

Large electrical currents detected over the South Pole during a solar flare offer evidence that atmospheric electricity is directly influenced by the Sun, according to a NOAA scientist.

These findings sharply contradict the prevailing "global circuit theory," which describes how electricity flows from the Earth to the atmosphere and back again. This theory holds that the electrical current which flows upward from thunderstorms is balanced by a weak, but widespread, air-to-Earth current observed in fair weather and that the global circuit of atmospheric electricity is controlled solely by thunderstorms.

The recently analyzed South Pole measurements provide strong evidence to the contrary and indicate that bursts of energetic particles and radiation from solar flares strengthen this ordinarily weak return current. This would make the Sun an important partner in regulating electricity in the global atmosphere. In addition, it is possible that this increased electrical activity may cause the formation of more lightning strokes in thunderstorms, which in turn could affect the rain-producing efficiency of the 1,500 thunderstorms estimated to be in progress over the Earth's surface at any given moment.

The electrical currents were detected last November by balloon-borne "electrosondes" launched from Amundsen-Scott Station as part of a continuing research effort by the Atmospheric Physics and Chemistry Laboratory, one of NOAA's Environmental Research Laboratories, in Boulder, Colo., and the National Science Foundation.

Coincidentally, the first balloon was released 7 hr before a solar flare occurred. While that sounding showed the atmospheric electrical conditions in their normal state, subsequent ones detected a strong increase in the air-to-Earth current over the next 2 days, which finally exceeded the measuring capacity of the electrosonde at altitudes of 16 to 19 mi (25 to 30 km). From the stratosphere to the surface the measured electrical current exceeded values obtained before the flare by more than 70 percent. This surge was followed by a gradual return to the weak "normal" current that flows from the atmosphere to the Earth in fair weather.

These large flucturations in electricity strongly reinforce previous findings at mountain observatories in Hawaii and Germany that indicate the global circuit theory should be revised to accommodate solar, as well as thunderstorm, effects.

NOAA PUBLISHES REVISED NAUTICAL CHARTS

NOAA has published new editions of five nautical charts for the Great Lakes. The charts are listed in the National Ocean Survey's Nautical Chart Catalog 4 - United States Great Lakes and Adjacent Waterways.

The new charts can be obtained from National Ocean Survey, Distribution Division (C44), Riverdale, MD 20840, (301) 436-6990; Counter Sales: 6001 Executive Boulevard, Room 101, Rockville, Md., (301) 443-8005; or from local marine supply agents. Mail orders should include check or money order (in U.S. funds) made out to the Department of Commerce/NOS.

State	Chart Number	Chart Title	Edition/Date	Price
Great Lakes	14860 (LS-5)	Lake Huron	26th 6-24-78	$3.25
Michigan	14930 (LS-758)	St. Joseph and Benton Harbor	20th 7-8-78	$3.25
Michigan	14942 (LS-789)	Lake Charlevoix	20th 6-17-78	$3.25
Michigan/ Wisconsin	14917 (LS-723)	Menominee and Marinette Harbors	19th 6-10-78	$3.25
Minnesota	14995 (LS-822)	Western Kabetogama Lake	9th 7-8-78	$1.40

SEASAT STOPS TRANSMITTING

An apparent massive short circuit shut down the ocean-monitoring satellite SEASAT, an unmanned,

5,050-lb vehicle carrying scientific instruments to measure ocean currents, tides, waves, surface temperatures, cloud patterns, and ice fields. It was launched into space on June 26, 1978.

The information which scientists had hoped to receive from SEASAT-A during its planned 1-yr lifetime was expected to provide new insights into the forces driving the Earth's ocean systems.

The satellite had been operating normally in its 500-mi-high orbit, and it was transmitting data to a tracking station in Australia when it developed the trouble. The last few bits of telemetry data received from SEASAT showed that something was pulling an abnormally large current flow out of its batteries, an indication of an electrical short circuit. Then the SEASAT abruptly ceased all further transmissions on October 10.

More than 90 days of data had already been obtained, and it is being processed. See page 344 of the September 1978 issue of Mariners Weather Log for examples of the data received. A ground truth experiment has recently been completed over the Gulf of Alaska to evaluate data received from the satellite.

WMO MARINE WEATHER QUESTIONNAIRE

The World Meteorological Organization has published a questionnaire concerning marine meteorological services. The questionnaire will be published in "Notices to Mariners Nos. 46 and 47" (November 18 and 25, 1978). They may also be obtained through any Port Meteorological Officer.

We hope all mariners will complete the questionnaires, which will be used to assist the various National Meteorological Services in improving their services.

TANKER, CREW WIN CITATION

The U.S. maritime industry and the National Safety Council honored a 35,000-ton U.S.-flag tanker and her crew for successfully carrying out the rescue of five persons from a sailboat during a storm off the Boston Pilot Station on October 9, 1977.

The ALLEGIANCE, owned by IOT Corporation of Philadelphia, won a citation of merit in the Ship Safety Achievement Awards contest. The award is sponsored annually by the American Institute of Merchant Shipping (AIMS), the National U.S.-flag shipowners association based in Washington, D.C., and the Marine Section of the National Safety Council, composed of maritime industry and government safety leaders on all three coasts.

Citations for "highly meritorious service" were presented to the master of the ALLEGIANCE, Captain R. Bridgeo, and to Robert B. Rogers of IOT Corporation.

GREAT LAKES OBSERVATION FORMS AND MAILING ENVELOPES

The following item of interest to Great Lakes vessels was received from Fred Day, Port Meteorological Officer, Sault Ste. Marie, Mich.

"As a result of a good suggestion from Captain Tatar, Master, Cleveland Cliffs steamer WILLIS B. BOYER, the National Weather Service has made arrangements with the U.S. Army Corps of Engineers to distribute weather observation forms and mailing envelopes from the Reporting Room at the Soo Locks. Cooperative weather reporting vessels transiting the Soo Locks may pick up observation forms and envelopes at the Locks if your onboard supply runs out.

"From time to time, a small supply of other items of interest to Great Lakes mariners may be available at the Reporting Room."

KUDOS TO STEAMSHIP CALLAWAY

A special weather observation from the CASON J. CALLAWAY on September 6, 1978, was extremely beneficial to the National Weather Service Forecaster at Duluth, Minn., and showed, once again, how valuable marine weather reports are in giving first indications of weather hazards.

The following message, which explains the details of the incident, was transmitted on a National Weather Service teletype circuit by the Duluth Forecaster:

"OUR THANKS TO THE STEAMSHIP CALLAWAY FOR THEIR TIMELY REPORT OF THE WINDS SHIFTING TO THE NORTHEAST. AT ABOUT 1854 PM THE CALLAWAY REPORTED A SQUALL WITH WINDS FROM THE NORTHEAST GUSTING TO 50 KNOTS. THERE WERE A LARGE NUMBER OF LOCAL SAILING VESSELS OUT IN THE LAKE AT THE TIME AND THE COAST GUARD DISPATCHED A VESSEL IMMEDIATELY TO WARN THE SAILBOATERS. BROADCASTS WERE MADE BY THE U.S. COAST GUARD AND THE NATIONAL WEATHER SERVICE AND ALL THE SMALL CRAFT REACHED PORT WITH NO SERIOUS INCIDENTS.

ONCE AGAIN OUR THANKS TO THE STEAMSHIP CALLAWAY."

The CALLAWAY is in the United States Steel Fleet, and her Captain is Perry S. Klumph.

AMVER'S 20TH BIRTHDAY

On July 18, 1978, the U.S. Coast Guard's AMVER system, "The Lifesaving Computer of the Seas," completed its 20th full year of service to the mariners of the world. Day and night for the last 20 yr, the tireless electronic brain of AMVER's computer has kept track of thousands of merchant vessels as they navigated the high seas. In 1977, ships flying the flags of over 80 different nations participated in AMVER.

When a distress occurs, the computer can provide a listing of vessels predicted to be in that area, and can help choose the one best-suited to give assistance. Called a "Surface Picture," this vital information can be made available to the Rescue Agency in any country within minutes and can save valuable time in the coordination of search and rescue operations at sea.

AMVER is a name which many seafarers have cause to remember over the past 20 yr. The system is credited with saving countless lives at sea, in instances ranging from ship fires and sinkings to medical emergencies and man overboard cases. The value of ships and cargoes kept from going to the bottom is in the untold millions of dollars.

Each case sounds its own note of urgency: a ship's master is ill and desperately needs a doctor; a merchant vessel on a distant ocean has flames racing through her cargo holds; a seaman has been critically injured in a shipboard accident. The information stored in AMVER's computer can mean the difference between life and death. This is why the experiment begun in 1958 has turned into one of the big success stories of modern maritime history.

The beginnings of the AMVER system were in a modest hand-calculated plot of shipping limited to the U.S. Coast Guard's Atlantic Ocean area of maritime SAR responsibility. This involved ships sending position reports from within the area so their locations would be known if an emergency arose. As the quantity

of shipping increased, the laborious hand-plotting procedure proved inadequate, prompting the purchase of an IBM RAMAC 305 computer in 1958. With the plotting function automated, it became feasible to extend the area within which ships could be tracked to longitude 15°W, limited still to the North Atlantic. This occurred in 1960.

AMVER was expanded to the Prime Meridian in 1963, and further eastward to the North Sea, Mediterranean and South Atlantic area in 1964. By that time, the electronic equipment then in use had become outdated and inadequate. Computer technology had progressed to a point where a new and more efficient system could be obtained--the IBM 1401. AMVER's coverage was expanded in 1965 to serve both the North and South Pacific using the new computer system.

At present, a CDC 3300 serves AMVER's needs and is programmed to plot all offshore voyages greater than 24 hr in length anywhere between 83°N and 83°S. The 1,500 emergency Surface Pictures supplied during a typical year testify to the use made of the AMVER system.

The AMVER system has undergone many changes since those early days--equipment is constantly being refined and updated; more and more ships participate every year; the communications network expands to include more countries. But, AMVER by no means has attained its full potential.

About 30 percent of all ships at sea now participate in AMVER, thanks to the superb recognition and support from shipowners and masters alike. But the U.S. Coast Guardsmen who operate the system are dedicated to increasing that percentage and meeting the goal that, for those who journey on the oceans of the world, "No Call for Help Shall Go Unanswered."

LORAIN, OHIO, COAST GUARD STATION HONORED

The Lorain, Ohio, Coast Guard station was awarded the NOAA Special Service Award on August 9, 1978 (fig. 32). The award was presented to Chief Larry Annon by Chief Meteorologist Marvin E. Miller in appreciation of significant services rendered by the station for the National Weather Service. It was the first station on the Great Lakes to receive the award.

The Lorain station records and transmits weather reports on wind direction and speed, water temperature and conditions, wave heights, and atmospheric pressure. This information is transmitted by VHF radio to boaters and is used by the National Weather Service to aid in preparing forecasts. About 40 percent of the boats registered in the United States are used on the Great Lakes, and more than half of these are on Lakes Erie and St. Clair.

The citation read: "For excellent cooperation over the years in taking weather reports every two hours, for providing outstanding service to the boaters in an extremely hazardous area, and for assistance in installing new wind equipment on an 80-foot tower and maintaining weather equipment, keeping it in top shape. Many times a boat was sent out on the open lake to obtain wave reports, and when it found that waves were extremely high, small-craft advisories were issued on the basis of their boat observations. The cooperation from the Lorain Coast Guard station has been outstanding."

Figure 32.--Five of the Lorain Coast Guard station personnel. The others were busy on two rescue calls.

SEA POLLUTION, EARTH HEAT STUDIED BY SATELLITE

Two highly complex instruments carried into space with the launch of the NIMBUS-G satellite could provide scientists with the answers to two extremely basic questions of importance to mankind: How polluted are the world's oceans and is the Earth warming up or cooling down?

The instruments are vital to studies being conducted by NOAA scientists and to other researchers concerned with the oceans and the atmosphere.

NIMBUS-G is a research and development satellite managed by NASA's Goddard Space Flight Center in Greenbelt, Md.

One instrument, the Coastal Zone Color Scanner, is expected to aid oceanographers in determining the content of water, important in monitoring water pollution. The scanner, sensing the colors in water beneath the polar-orbiting satellite, will permit content analyses to be made of large areas of coastal or ocean waters, letting oceanographers view the ocean as never seen from ships. The instrument will be used to determine how well water pollution--such as oil spills, sewage and industrial waste dumpings, and river sediment--can be detected and tracked.

The other instrument, the Earth Radiation Budget experiment, makes a variety of measurements of the radiation coming from the Sun and the Earth. Of particular interest to scientists is the observation of variations in the radiative heat exchange between the Sun and the Earth with time, with location on the Earth, and over the entire globe.

The observations can help in monitoring, and perhaps eventually anticipating, the fluctuations in climate from months to a few years. This radiative heat exchange creates the basic energy source for the atmospheric and oceanic circulations that determine climate. For example, variations in radiative heating between the Tropics and higher latitudes, or between the oceans and continents, may yield important clues to the types of winters or summers to be expected to occur in the United States or other parts of the world.

NOAA WEATHER RADIO NATIONWIDE

NOAA Weather Radio, a fast-growing network, will saturate the Nation within the next year with continuous broadcasts of storm warnings and the latest weather observations and forecasts--24 hr a day, 7 days a week.

Some people call it push-button weather, because it is always there when you want it. Already there are more than 200 stations operated by the National Weather Service, and the pace of installations is accelerating because people like it so much. When completed next year, there will be about 340 stations, covering 90 percent of the U.S. population (fig. 33).

The NOAA Weather Radio program began in the 1960's to serve recreational boaters, but since then it has expanded to cover just about everyone. The "NOAA" part of its name stands for National Oceanic and Atmospheric Administration, a major component of the U.S. Department of Commerce, and the parent agency of the National Weather Service.

Proof of NOAA Weather Radio's popularity is that many States have volunteered to provide facilities, and in some cases manpower, to augment and speed its availability. The Weather Service currently has 30 such Federal and State agreements.

Here is how it works. During good weather, the latest observations and forecasts are tape-recorded by local Weather Service offices in messages of 3 to 5 min. These messages are replayed continually, guaranteeing reception any time of day or night at the push of a button or the twist of a dial. The messages are revised every 3 to 4 hr or more frequently when appropriate. When severe weather threatens, forecasters at the local Weather Service office interrupt the broadcasts with storm warnings, either tape-recorded or "live" as the situation demands.

Furthermore, the system has a feature which allows an automatic alert when dangerous weather such as a tornado or flash flood is on the way. Radio receivers available for about $35 will silently monitor the NOAA weather broadcasts and automatically either sound a siren or come up to audible volume when the forecaster presses a button signaling that a storm bulletin is forthcoming. These "warning-alarm receivers" are especially valuable for schools, hospitals, nursing

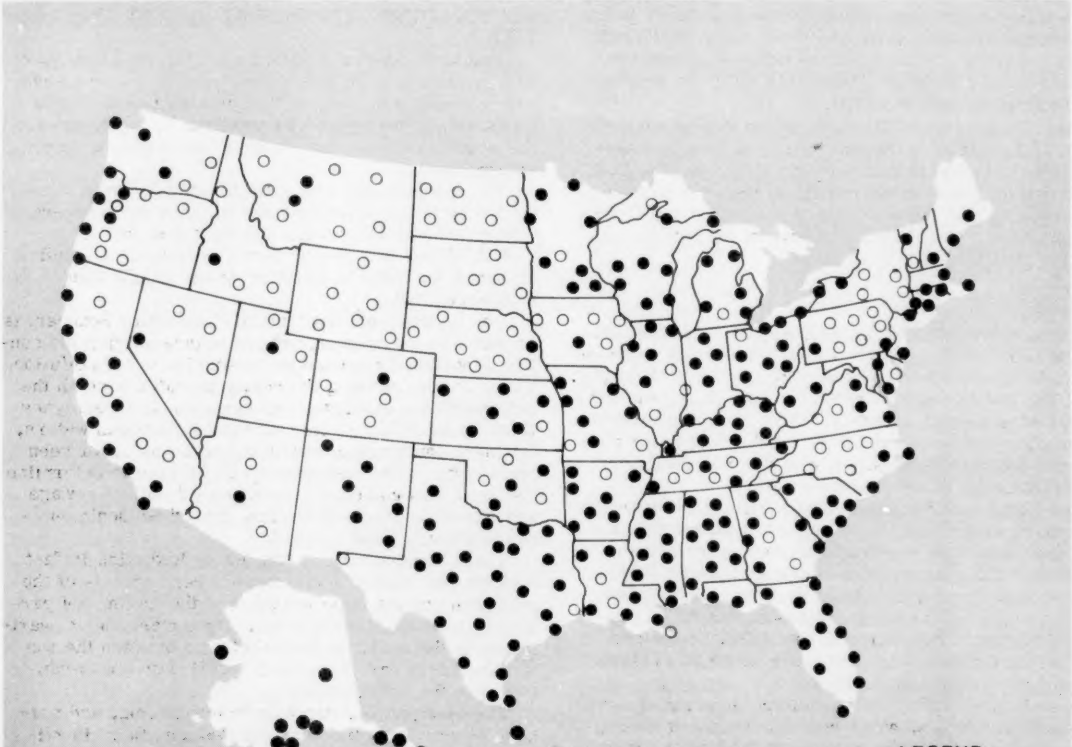


Figure 33.--Present and planned locations of NOAA weather radio stations.

homes, factories, mobile-home communities, and other places where large numbers of people are congregated. They also are of vital importance to radio and TV stations and public-safety officials.

Because of its unique warning capability, NOAA Weather Radio was designated in January 1975 by the White House Office of Telecommunications Policy as the sole Federally operated radio system to provide warnings directly into people's homes--not only for natural disasters, but also in the event of nuclear attack.

The kind of receiver needed is one that will receive very high-frequency FM broadcasts--considerably above commercial FM broadcasts, which end at 108 MHz. The frequencies used for NOAA Weather Radio nationwide are 162.40, 162.475, or 162.55 MHz. Most radio-specialty shops and many other retail outlets have such "high-band" receivers, some for as little as $10 or $15 without the automatic storm-warning feature.

The effective range of broadcasts is about 40 mi, depending upon the terrain and the quality of the receiver. Because of the high frequency, transmission is by line of sight, like television, and may be blocked or interfered with by hills, nearby buildings, or commercial radio transmitters. Such problems may sometimes be overcome, or listening range extended, by use of high-quality receivers and high, outside antennas.

Because of these uncertainties, the Weather Service advises people to make final acceptance of a receiver conditional upon a test in the setting in which it is to be used. It urges institutional buyers to select a high-quality receiver with great sensitivity and selectivity.

It is also worth noting that you can purchase receivers that will pick up NOAA Weather Radio broadcasts when you are traveling, as you move from the range of one station to another, so that you will have a continuous source of local weather reports. As the system grows, you will seldom be out of range for very long of a local NOAA Weather Radio broadcast when traveling on interstate highways.

A.M. WEATHER AIRED BY PUBLIC BROADCASTING

Three NOAA meteorologists helped to produce the most comprehensive television weather program ever developed for national viewing.

STATIONS CARRYING A.M. WEATHER

Figure 34.--Locations of Public Broadcasting stations carrying A.M. Weather as of October 1978.

The program is designed primarily for private pilots and other aviators, but also it will have special appeal to practically anyone including mariners inland and near-shore needing comprehensive weather information for planning purposes. Local weather facilities including NOAA weather radio should be contacted for detailed local weather forecasts, watches, and warnings.

The 15-min program, called "A.M. Weather," began October 30 and is telecast on Monday through Friday at 6:45 a.m. and 8:45 a.m. EST, with two taped broadcasts at 7:45 a.m. and 9:45 a.m. EST. Local stations broadcast the shows at times of their own choosing. It is produced by the Maryland Center for Public Broadcasting and then distributed to other public broadcasting stations throughout the United States (fig. 34).

Each show includes an overall look at the nationwide weather, a description of factors expected to affect the weather for the next 2 days, and detailed forecasts for various regions. Weather maps, satellite photographs, and other visual aids are used to promote easy understanding. The programs will stress understanding the weather, making them valuable for science teachers to videotape and replay for their students.

A.M. Weather follows upon "Aviation Weather," a popular weekly program produced on Friday evenings by the Maryland Center from 1972 to 1976. Like its forerunner, A.M. Weather is a joint effort. Funding is being provided by the Federal Aviation Administration and the Aircraft Owners and Pilots Association. Also cooperating are the General Aviation Manufacturers Association, the National Business Aircraft Association, and the National Pilots Association.

HALL OF AMERICAN MARITIME ENTERPRISE

They were called CHALLENGE, LEVIATHAN, and the UNITED STATES. Over the past three centuries, they were among the proud ships which led America's commercial sailing fleets through triumph and tragedy. Their stories, and those of other great merchant ships, are visually told in the new Hall of American Maritime Enterprise which opened at the Smithsonian National Museum of History and Technology in Washington, D.C., in August.

The exhibit, which covers 12,000 ft^2 and took 4 yr to plan and complete, covers all aspects of commercial shipping in America. Ship models, period rooms, audio-visual devices, and small theaters contribute to the story of life at sea and along the inland waterways.

Historian Robert C. Post and the Museum staff have acquired thousands of objects, some never exhibited before, from private collections, museums, maritime companies, and on-site locations.

An operating lighthouse lens at the entrance came from Table Bluff on Humboldt Bay, Calif., and its base is from a lighthouse at Bolivar Point on Galveston Bay, Tex. A fully outfitted whaleboat (figs. 35 and 36) is from the CHARLES W. MORGAN, last of the American square-rigged whaling ships. Wood paneling from the LEVIATHAN, the first great luxury liner to sail under

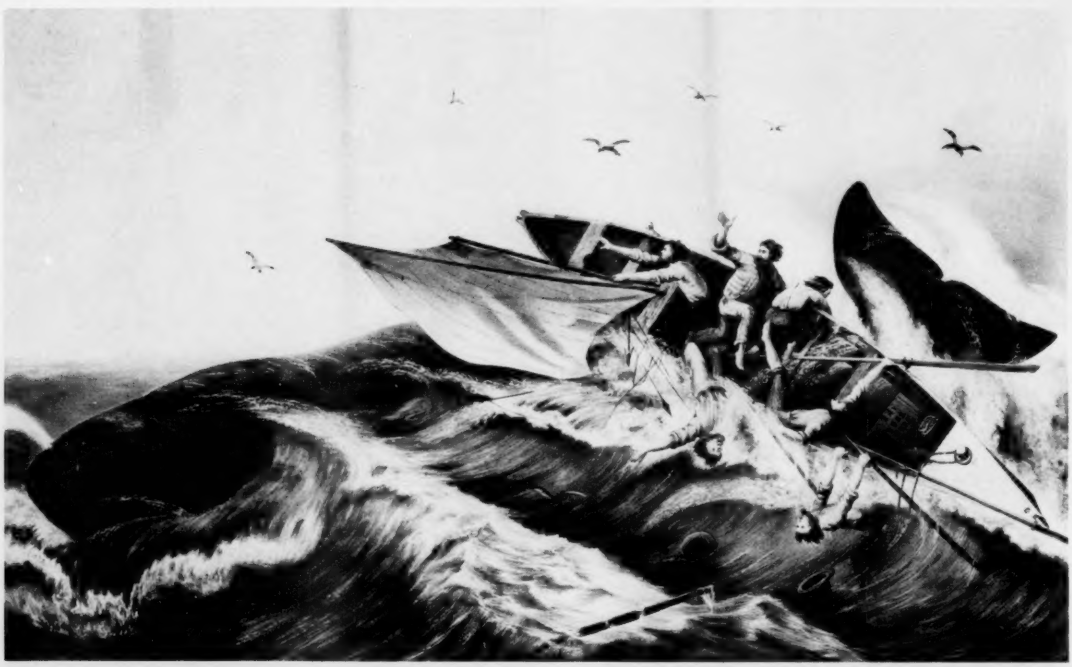


Figure 35.--Lithograph (1858) by J. Cole entitled "The Conflict." Photo courtesy of National Museum of History and Technology, Smithsonian Institution.

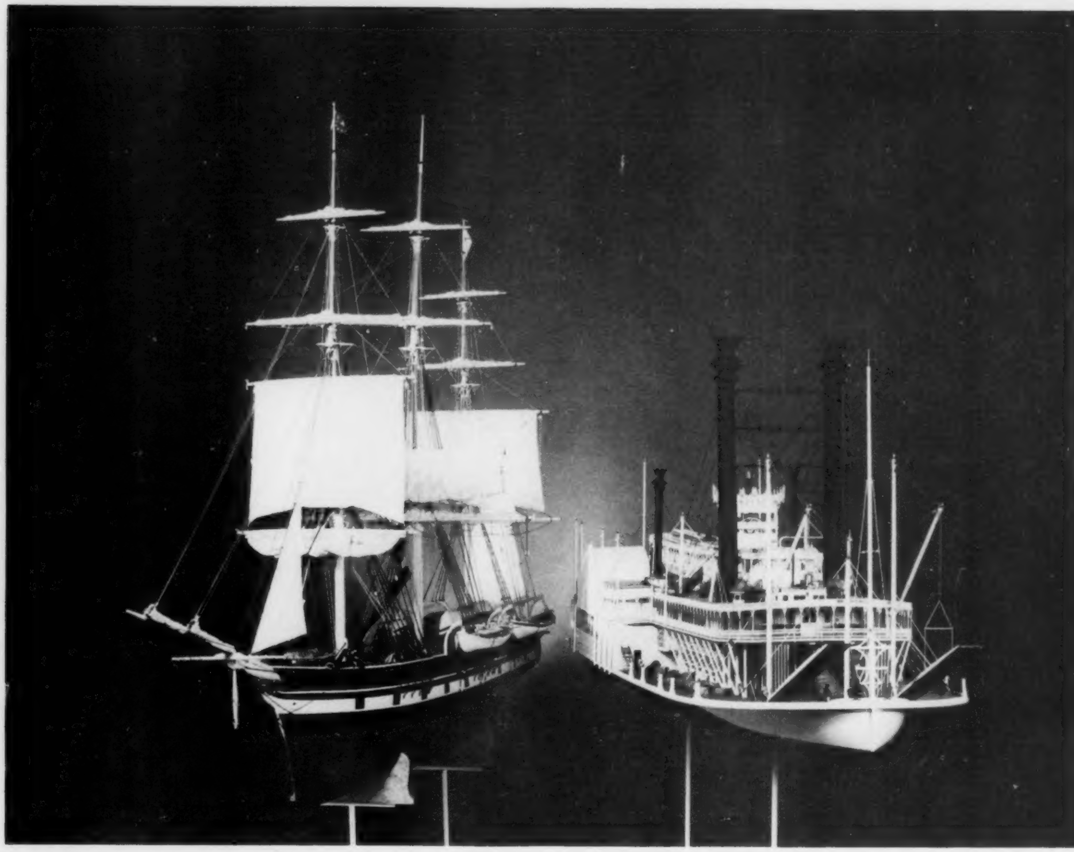


Figure 36.--Two types of early ships. On the left is a model of a typical whaleship (1850-75), and on the right the J.M. WHITE, a western sidewheeler. Photo, Smithsonian Institution.

the American flag, came from a recreation room in Long Island.

Visitors may enter two full-sized exhibits: a 1970's towboat pilot house and the working engineroom of a ship. In the pilot house, visitors can see the equipment used to operate the vessel along inland waterways and a film of passing scenery which simulates movement along a major river. The sight through the window is similar to what Mark Twain might have seen. One enters the deckhouse from the S.S. OAK and looks below at a complete operating engineroom. The S.S. OAK was a Coast Guard ship that tended buoys from the 1920's to the 1970's.

A central feature of the hall is the National Watercraft Collection, started in 1884 by Captain Joseph W. Collins. Considered to be one of the finest ship model collections in the world, it includes hundreds of half-models and rigged models (fig. 37). The schooners, clipper ships, fishing craft, and riverboats represented show the interaction of economic needs and technological advances. Steam power displaced sail power; and therefore, the sizes, weights, materials, and designs for ships also changed.

One of the largest models in the hall is the BRILLIANT, a 13-ft, three-masted tobacco ship built in Hampton Roads, Va., which sailed at the time of the American Revolution. A full-sized section of the BRILLIANT's foremast and rigging stands near the model, which is one-tenth the size of the original ship.

Several period rooms in the hall relate to the past. There is an 18th century warehouse from a tidewater Virginia port. Its barrels, ropes, and assorted supplies are shown as they might have looked on the eve of the American Revolution. A marine insurance office from the 1880's is shown with the furnishings and decorations of the time. A skylight of stained glass surrounded by a raised relief frieze with different sailing scenes is from the luxury liner MAJESTIC of 1889.

At the end of the exhibit is a complete tattoo parlor surrounded by vintage tattoo parlor furniture, tattoo kit, and a mannequin decorated with tattoo designs through a special projection system.

The exhibition is divided into 10 sections, each recounting some facet of history which is illustrated by a rare artifact. There is a china bowl and platter that belonged to George Washington, a patent application from Abraham Lincoln for his (impractical) device to

Figure 37.--A model of the TILLIE STARBUCK (1883). The ship was built for service between the East and West coasts and was the only full-rigged American ship made of iron and steel. She set a record for speed under sail from New York to Portland. Photo, Smithsonian Institution.

lift boats over shoals. There are photos, china, silver, furniture, and other mementos from famous showboats, riverboats, and luxury liners.

Numerous works of art throughout the hall depict nautical scenes or noted inventors and maritime leaders. There is Charles Wilson Peale's 1807 portrait of Robert Fulton. There is the only known surviving lithograph of "View of Honolulu from the Catholic Church" (1854) by Britton and Rey. And, there is the first highly popular lithograph by Nathaniel Currier called "Awful Conflagration of the Steam Boat Lexington" (1840). This lithograph sold by the tens of thousands, but today only a handful survive. Thomas Moran's etching "The Much Resounding Sea" (1886), considered one of his best and most famous nonwestern scenes, is also included, as is Ivan Mestrovic's 1936 bronze bust of Andrew

Figure 38.--This scrimshaw lantern has a wooden frame with four panels at the top inset with whale bone. An inscription reads, "Happy is he who findeth light, 1859, John Denton." Photo, Smithsonian Institution.

Furuseth, organizer of the first American seaman's union. Several paintings in the hall by Chinese artists show Western ships and there is even a Chinese copy of a Gilbert Stuart "George Washington."

There is a 12-ft display of a modern lock and pool system in which a small river towboat will travel through a working lock.

The oldest single object in the exhibit is a 1733 map of the British Empire in America. It is the largest map of North America printed during Colonial times. One of the rarest objects is the steam engine built by John Stevens in 1804 to power his LITTLE JULIANA on the Hudson River. It is also the oldest surviving steam engine made in America. One of the most unusual lifesaving devices shown is the metallic "life-car" developed for shore-based rescue operations in the 1840's by Joseph Francis. This unstable-looking life car rescued all but one of the 202 passengers on the immigrant ship AYRSHIRE when it grounded off Squan Beach, N.J., in 1850.

An important new scrimshaw collection from Dr. and Mrs. Wilbur J. Gould will also be introduced in the Maritime Hall. More than 30 examples of this seaman's art will be shown including whaling scenes and ship portraits engraved on whale teeth. Among the pieces made from whale bone are a lantern (fig. 38), a hand telescope, and a whale stamp.

There are two theaters in the exhibition. One shows Hollywood film clips of disasters at sea such as the "Titanic" and "Poseidon Adventure." The other shows documentary film footage of shipbuilding efforts during World War II, ship launchings, and President Franklin D. Roosevelt's encouragement to America's shipbuilders.

The new hall was designed by Nadya Makovenyi of the Museum staff. She used a nautical theme throughout, choosing yellow pine for the walls and sisal (rope-like) carpeting. Among the design features in the hall are a set of slide shows about America's ports, which is viewed through four portholes, a time-line room that tells the whole story of American maritime enterprise, and an oversized canopy from a riverboat that provides a dramatic setting for a section on inland waterway transportation.

The exhibit was supported by generous grants from individuals, organizations, and corporations associated with American maritime industries.

LETTERS TO THE EDITOR

TARNIMARA ATLANTIC CROSSING

Mr. Robert Browne of Thunder Bay, Ontario, Canada, sent this interesting letter, chart (fig. 39), and partial copy of the log for the voyage of the 32-ft sloop TARNIMARA from Halifax, Nova Scotia, to Plymouth, England. They departed on May 27, 1978, and arrived on June 19, 1978. The weather was cloudy most of the voyage, so celestial fixes were few.

The chart gives the average daily weather, winds, pressure, and air and sea temperatures. These will not be readable when reduced to publication size. They received several fixes from ships, but mostly the navigation was dead reckoning. On June 14-15 (day 19-20) they encountered stormy weather with winds gusting to 70 kn and maximum waves building to 40 ft. The winds were measured winds. As they neared Ploneis, they were able to obtain console and radio bearing lines of position. With the strong northerly winds, they found themselves much farther south on the 16th than DR indicated. On the 17th they turned northward for landfall and followed the coast into Plymouth.

Thunder Bay, Ontario
Canada

September 21, 1978

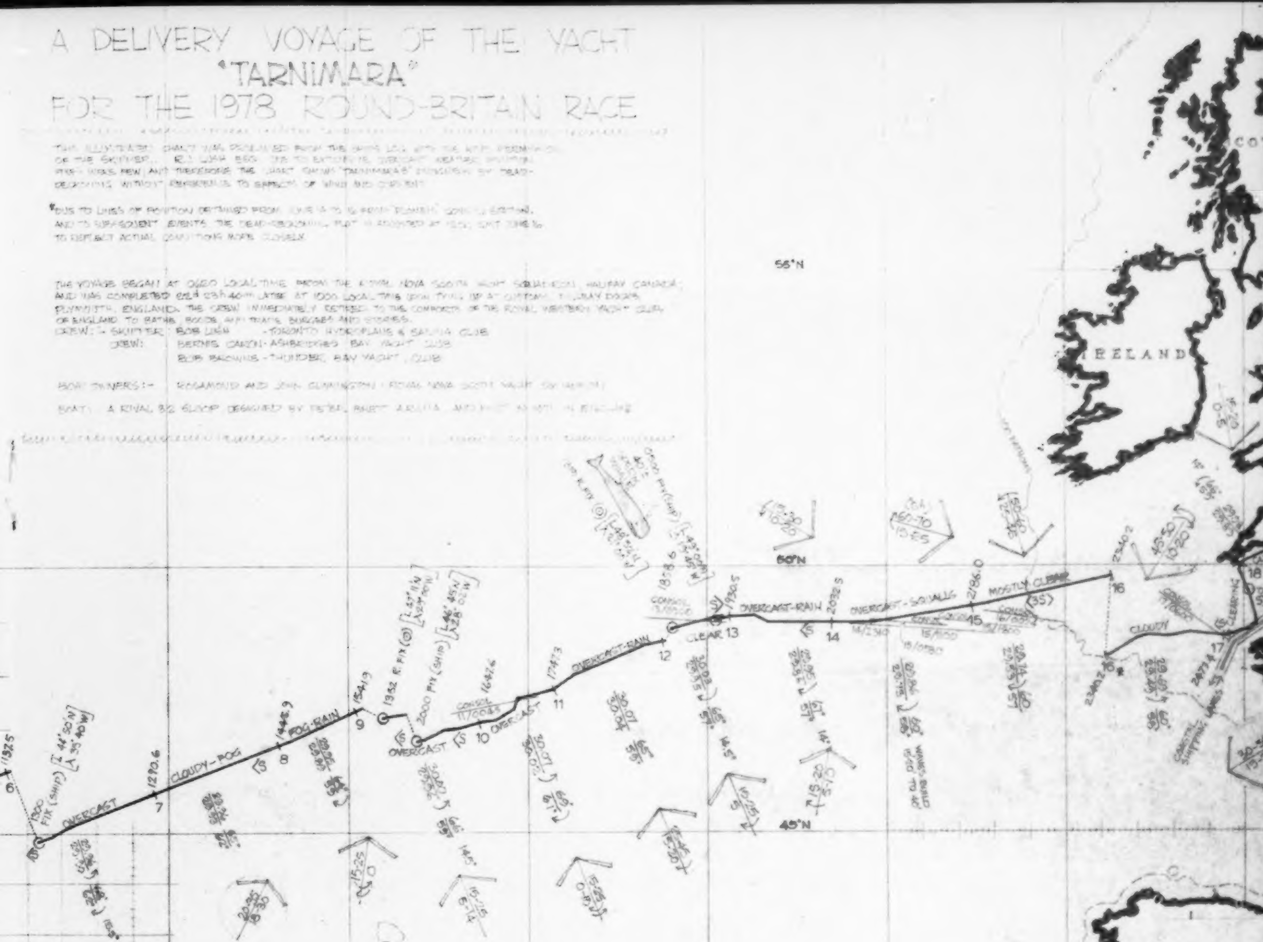
The Editor
Mariners Weather Log
Environmental Data and
Information Service, NOAA
Washington, D.C. 20235

Dear Mr. Wilson:

I just received the September issue and read the Rough Log for June 78 - North Atlantic. We made a delivery voyage of a 32-ft yacht from May 27 to June 19, inclusive, and I enclose a copy of our illustrated chart for your information in preparing the Smooth Logs.

Our ship's log consisted of hourly entries of time, wind directions and strength, barometer pressure, distance

Figure 39.--The track of the TARNIMARA showing winds, seas, and fixes.



A DELIVERY VOYAGE OF THE YACHT
"TARNIMARA"
FOR THE 1978 ROUND-BRITAIN RACE
55°N
50°N
45°N
40°N
35°N
IRELAND
AZORES
OVERCAST
CLOUDY-FOG
FOG-RAIN
OVERCAST
OVERCAST-RAIN
CLEAR 13
OVERCAST-RAIN
OVERCAST-SQUALLS
MOSTLY CLEAR
CLOUDY

log (which had to be corrected downwards by 18 percent) and comments, and, of course, our ship's heading (compass). The plot on this chart does not take into account wind drift, or current. And as you may expect, we paid attention to the console bearings we obtained June 14 to 16, and they coincided with our adjusted plots made at the time.

If you have any detailed questions for information from the Log, please contact Robert Lush, 5 Bellefair Avenue, Toronto, Canada, as he has the original copy of the log. My photocopy is rather faint and not reproduceible again.

We hope you find this record interesting. Both Bob Luch and I greatly appreciate receiving your publication.

Sincerely,

Robert Browne

WATERSPOUT

Captain C.P. Nilsen of the SAN JUAN sent the photograph of a waterspout shown in figure 40. The waterspout occurred at 2330 on June 25, 1978, near 33.9°N, 71.35°W. The SAN JUAN was on a voyage from San Juan, Puerto Rico, to New York. The weather at the time was: wind - WSW force 3, barometric pressure - 30.10 steady, air temperature - 72°F, and sea temperature - 80°F.

Figure 40.--The waterspout is on the left half of the picture.

MARINE WEATHER REVIEW

The SMOOTH LOG (complete with cyclone tracks [figs. 41-44], climatological data from U.S. Ocean Buoys [table 8], and gale and wave tables 9 and 10), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

Smooth Log, North Atlantic Weather

May and June 1978

SMOOTH LOG, MAY 1978--There was little rhyme or reason to the storm tracks this month. Those over and off the U.S. East Coast traced paths like a drunken sailor. Many storms looped and turned along their tracks. The only path that had a similarity to climatology was from southeast of Newfoundland into the Denmark Strait. Two storms from the Atlantic and one that moved southward across England entered the continent of Europe.

The main feature in the pressure pattern was the large Azores High at 1025 mb centered near 32°N, 38°W. It was 3 mb higher than and near its climatic position. The Icelandic Low was 1008 mb near 63°N, 30°W versus the climatic value of 1012 mb near 55°N, 37°W. A tongue of high pressure stretched down into Canada from near the North Pole. There was an anomalous high-pressure center near Scandinavia.

The large anomaly centers were all north of latitude 60°N. There was a positive 8-mb center over the Gulf of Bothnia and a positive 4-mb center over Hudson Bay. Greenland was surrounded by a negative 4-mb anomaly isoline with two minus 6-mb centers. One was over the central Ice Cap and the other south of the Denmark Strait. In the central Atlantic there were three spots with positive 4-mb anomaly values.

The upper air mean pattern differed radically from climatology at 700 mb. The trough that normally parallels the northeastern Canadian coast was shifted eastward to over Baffin Bay and east of Newfoundland. The trough then broke and was near its normal position off the U.S. East Coast. The anomalous surface HIGH over Scandinavia was reflected at 700 mb.

There were no tropical cyclones during May. June 1 marked the beginning of the season in the Atlantic. Over the past 30 yr the average number of named storms has been nine, six of which were hurricanes. An average of three storms cross the U.S. Coast, and one is a hurricane. The names were published in the May issue.

Extratropical Cyclones--May was a fairly quiet month with no extremely violent storms. The first storm formed as a frontal wave and was first analyzed on the 1200 chart of the 2d near 43°N, 54°W. There was an indication on the 0000 chart, when the LASH ATLANTICO reported a thunderstorm. At 1200 a SHIP near the cold front (41°N, 55°W) had 25-ft swells on her stern. Only a few miles to the east the JADRO had 44-kn southerly winds and 20-ft waves. By 1200 on the 3d, the 986-mb LOW was near 55°N, 50°W, and starting a cyclonic loop. A SHIP near 59°N, 47°W, reported 52-kn easterly winds. On the 4th the MEERKATZE (59°N, 46°W) and the MERCANDIAN CLIPPER (59°N, 48°W) had 50-kn easterlies with 21-ft seas. As the LOW completed the loop on the 5th, it died.

A storm moved northeastward out of the Gulf of Mexico on the 4th and broke into two centers. While on the Gulf Coast it produced tornadoes and heavy rain over Mississippi and Louisiana. Mobile, Ala., had 3.5 in in 2 hr. There were several cases of 3 to 6 in in 6 hr. Van Cleave, Miss., had 7.82 in in 10 hr. Many areas were flooded and some required evacuation.

The original LOW moved northward west of the Appalachian Mountains, and the new LOW developed over the Carolinas. At 0000 on the 6th, the 994-mb LOW was near 39°N, 68°W. The HAHNENTOR (37°N, 56°W) had 42-kn winds. At 0600 the MARINE NAUTICA (47°N, 60°W) northeast of the center found 50-kn storm winds.

The storm had moved to 40°N, 50°W, by 1200 on the 7th. It passed over the AMERICAN LEGEND which had 45-kn northerly winds at this time. The seas were reported as 28 ft and the swells 20 ft. On the 8th the ARCTIC TROLL was west of the LOW with 60-kn winds out of the north. The TOM JACOB was being washed down by 60-kn northerly winds driving heavy rain near 50°N, 39°W, on the 9th. The waves were 20 ft. The stronger winds in this storm appeared to be west of the center. At 1200 the center of the 993-mb storm was within 2 mb of OWS Charlie. At 1800 the winds were measured as 45 kn with 21-ft seas. The 40- to 50-kn winds continued through the 10th and 11th as the storm moved over Iceland. Late on the 11th and early on the 12th, the ADMIRAL W.M. CALLAGHAN was in the vicinity of 57°N, 19°W, with westerly winds up to 40 kn and waves as high as 18 ft. The storm lost its punch over the Norwegian Sea, where it meandered until the 15th.

This LOW formed in the wake of a frontal wave that was traveling northward toward the Denmark Strait. At 0000 on the 6th the 995-mb storm was near 50°N, 38°W. At 0600 the AMERICAN ACE was 4° latitude to the south with 40-kn westerly winds and 24-ft seas. Twelve hours later the EXPORT LEADER (48°N, 31°W) was in approximately the same position relative to the center of the storm with 21-ft seas.

On the 7th a frontal wave developed about 900 mi southwest of the center and raced eastward. At 1200 it was 990 mb near 48°N, 27°W. The AMERICAN LEADER sent an off-time observation at 1100 reporting 23-ft seas and 30-ft swells. Both storms turned northwestward on the 8th and disappeared off the southeastern coast of Greenland.

A closed cyclonic circulation was found on a weak front over North Dakota on the 0000 chart of the 11th. It deepened and moved northeastward north of the Great Lakes. At 1800 it was north of Thunder Bay at 995 mb. The JOHN DYKSTRA was on Whitefish Bay and measured 45-kn winds from the south ahead of the cold front. The waves were 8 ft. The LOW continued northeastward then northward over Baffin Bay.

In the meantime another LOW had formed over Nebraska and South Dakota and moved eastward. At 1200 on the 13th it was centered south of Chicago at 989 mb. At 1800 the GEORGE A SLOAN was on Lake Michigan east of Green Bay and measured 35-kn winds with 11.5-ft seas. On the 14th two ships measured 45-kn winds. The JOHN G. MUNSON was near Chicago with northerly winds and seas of 10 ft. The THOMAS WILSON was near La Canadienne Point with northeasterly winds and 6.5-ft seas. This center broke up as another formed east of the Appalachian Mountains.

During the middle of the month high pressure settled east of Newfoundland blocking any severe LOWs. It slowly drifted toward its normal position near the Azores Islands.

A LOW center formed over Europe in the northern part of a trough connected with low pressure over North Africa on the 22d. It remained virtually stationary and deepened as the Azores High drifted southeastward. This resulted in a tight pressure gradient off Europe's west coast. On the 23d ships were reporting 40- to 60-kn winds off Portugal and Spain. Two reported winds of about 60 kn. They were the GORNIK and FAPI near 37°N, 09°W. Others had gales in the 40-kn category. OWS Romeo was tossed by 20-ft seas. On the 24th the LOW appeared to leap into the Balkins weakening the gradient.

This storm formed in the lee of the Rocky Mountains over the Plains States on the 18th. As the center neared the coast on the 22d a Norwegian ship had 44-kn winds near Sable Island. At 1200 the 982-mb LOW was over the Strait of Belle Isle. Two Canadian ships, the HUDSON and NORTHERNSHELL, were near 47°N, 55°W, with 40-kn westerly winds. On the 23d the LOW stalled over the Labrador Sea for 24 hr. A Danish ship was in the Davis Strait with 60-kn winds from the northwest. The VASSIA CHICHKOVSKII near 53°N, 45°W, reported 20-ft seas. On the 26th another LOW took over the circulation.

Casualties--The British cargo ship PHOTINIA (10,506 tons) anchored south of Milwaukee in Lake Michigan dragged anchor and went aground in winds up to 50 kn and waves of 6 to 8 ft. She was refloated on July 7 with the assistance of seven tugs. The 102,326-ton tanker WORLD HORIZON sustained extensive damage to the bulbous bow and forepeak in heavy swell off Port Elizabeth on the 26th. The vessel was loaded and proceeding from the Persian Gulf to Curacao. Divers were unable to inspect the damage off Mossel Bay in

heavy weather. The inspection was made at St. Helena Bay.

SMOOTH LOG, JUNE 1978--The storm track pattern was generally displaced northward this month. There was a concentration of storm centers over the Canadian Northwest Territories north of Hudson Bay. The mean climatic storm track that passes over Lake Superior and up the St. Lawrence River Valley was oriented from Lake Winnipeg to James Bay to Kap Farvel. At Kap Farvel the track was joined by a secondary track out of the St. Lawrence River Valley. From Kap Farvel the track moved over the Denmark Strait. A few storms traveled eastward south of Iceland. Early in the month there were several storms over the central ocean between Newfoundland and Portugal.

The mean pressure pattern was dominated by the 1029-mb Azores High near 39°N, 38°W. This was 5 mb higher and about 400 mi north of its climatic position. A 1009-mb Icelandic Low was normally located east of Kap Farvel. A deeper 1007-mb LOW was centered over Committee Bay north of Hudson Bay. The anomalous LOW reflected the many storm centers over the Northwest Territories. The pressure over the eastern United States was 2 to 3 mb higher than normal.

The primary anomaly was a positive 10-mb center near 48°N, 39°W, reflecting the higher pressure and northern displacement of the Azores High. The LOW over northern Canada produced a negative 5-mb center near the LOW center. In general, the pressure over Europe was below normal, but there were only two weak short-lived LOWs over the mainland.

In the upper air at 700 mb the primary LOW center was shifted southward and nearly vertically stacked with a LOW over northern Canada. The surface was 88 m lower than the climatic mean. The trough paralleling the North American East Coast was sharper than usual with a pronounced ridge over the central ocean from 35° to 55°N.

There were the usual number of tropical disturbances, but none developed into more intense tropical circulations.

Extratropical Cyclones--June was a rather quiet month. No severe cyclones either tropical or extratropical affected the seas and larger vessels. On the 4th the DOCTOR LYKES ran into squalls over the Gulf of Mexico south of New Orleans. The 1800 report indicated 68-kn southerly winds.

This was not a single storm, but a series of frontal waves on the front that extended south of the parent LOW that moved eastward from Labrador. The first wave was analyzed near Cape Sable on the 1200 chart of the 4th. The MAYAGUEZ was southeast of the front near 32°N, 73°W, with 40-kn winds and rain within sight. A 1030-mb HIGH was drifting southeastward from near 45°N, 35°W. This produced a tight gradient on the eastern side of the front. The HUDSON was near 50°N, 45°W, and was struck by 38-kn winds out of the south at 0000 on the 5th.

By the 1200 analysis of the 5th this frontal wave no longer could be found, but a new one was indicated near 43°N, 55°W. The HUDSON was now near 50°N, 44°W, with heavy rain and 40-kn winds out of the southwest. The KOSMONAUT GAGARIN was near 49°N, 42°W, with 37-kn southerly winds. The SEALAND GALLOWAY was sailing westward along 43°N between 41° and 47°W on the 5th and 6th with 35-kn gales and waves up to 10 ft. The seas were generally running from 8 to 12 ft. This frontal wave was identifiable through the 0000 chart of the 7th.

The first week of the month a LOW had moved eastward across northern Canada. Early on the 7th the center was near Resolution Island. The 0000 chart of the 8th showed this LOW had disappeared, and another had formed about 300 mi to the north off Home Bay of Baffin Island. At 1800 on the 7th, a vessel near 60°N, 50°W, reported 37-kn southerly winds. The 0000 report of the 8th indicated the DANA was very near the center of the storm with 991-mb pressure and 44-kn southeasterly winds. She found seas of 26 ft and temperatures only slightly above freezing.

At 1200 the SISIMUT (67°N, 57°W) and another ship had 37-kn winds from the south with no seas reported. The LOW drifted northwestward, then southward over Baffin Island. It disappeared on the 10th as a LOW moved up the St. Lawrence River Valley.

This front was associated with the LOW described above. On the 9th a frontal wave developed over Maine. The LUCY MAUD MONTGOMERY was in the Gulf of St. Lawrence with 35-kn southerly winds. At 1200 the ALERT near 46°N, 58°W, and another ship had 36- and 40-kn winds, respectively. The LOW was 996 mb at 0000 on the 10th over Anticosti Island. The IXIA (44°N, 54°W) had southwesterly 43-kn winds blowing against her port side. On the 11th the NARWHAL (49°N, 54°W) was contending with 40-kn westerlies. It appeared that the storm would move into the Labrador Sea west of Greenland, but it turned to the northeast and skirted Kap Farvel. The winds were generally below gale strength.

On the 13th the POSEIDON was south of Kap Farvel with 40-kn winds and 16-ft seas. By 1800 the winds had risen to 48 kn and the seas had built to 26 ft. An English ship radioed 45-kn winds and 25-ft waves on the 14th south of Iceland. At 1200 the LOW was 988 mb near 60°N, 25°W. Nearly a dozen ships reported gale-force winds in the vicinity of Iceland that day.

On the 15th OWS Lima measured 35-kn winds with 16-ft swells. Romeo had 20-ft swells, while a ship between the two recorded 21 ft. By the 16th this center had disappeared, and a new one formed over Wales to become one of the few storms to traverse the continent.

The third week of the month the Azores High dominated the Atlantic from 15° to 50°N and coast to coast. It averaged around 1035-mb pressure and was centered in the vicinity of 40° to 45°N and 30° to 35°W. During the fourth week the HIGH broke down some, but held its own. Fronts were able to penetrate, and several small LOWs were analyzed on the edges, but they were not particularly significant. On the 27th and 28th a frontal wave pushed against the northwestern edge. The TRANSCOLORADO ran into 40-kn winds and 17-ft waves and another ship found 45-kn winds in the vicinity of 43°N, 46°W. There were other isolated reports of gale-force winds, but no systematic storm.

Casualties--The LAGADA BAY (4,530 tons) and the LOBITO PALM (5,923 tons) collided in fog in the

Benin River in Nigeria on the 1st.

The 11,034-ton YELLOWSTONE and the 2,839-ton IBN BATOUTA collided in fog on the 12th about 14 mi from Gibraltar. The YELLOWSTONE sank on the 13th, while the IBN BATOUTA proceeded to Cadiz.

The 5,668-ton Cypriot cargo ship BETTY encountered heavy weather after leaving Beirut on the 22d. The cargo shifted resulting in a heavy list. The Greek tug ATLAS assisted and towed to Piraeus. The Russian passenger ship MIKHAIL KALININ (5,243 tons) ran aground in heavy weather at Saxarfdjarden. The passengers and most of the crew left the vessel, which was later refloated and towed to Stockholm.

The tug IRMA sank during a storm off Pass Christian on the 29th. The fishing vessel CAPTAIN GIBBY sank during a squall at Empire, La.

Smooth Log, North Pacific Weather

May and June 1978

SMOOTH LOG, MAY 1978--The North Pacific suffered rougher weather this month than the North Atlantic. The storm paths were spread out, but they generally followed the climatological orientation. The primary path formed south of Japan and extended northeastward into the Gulf of Alaska. A few storms entered the Bering Sea. Also, several storms formed in midocean and contributed to those entering the Gulf of Alaska.

The mean-pressure pattern varied from the long-range climatology. Normally, there are three low centers of 1009 mb that comprise the Aleutian Low. This month there was one 1007-mb LOW over the Alaska Peninsula. The Pacific High was larger than usual and 5 mb higher in pressure at 1028 mb. The main center was near 39°N, 140°W, about 500 mi northeast of its usual position. A second 1026-mb center was near 35°N, 172°W.

The larger anomaly centers were positive. A positive 7 mb was near 46°N, 167°E, and a positive 6 mb was near 40°N, 138°W. Most of the ocean north of 20°N was positive, except for the Gulf of Alaska and eastern Bering Sea. This area had a negative 3-mb center near Kodiak Island.

The upper air pattern at 700 mb had more resemblance to climatology than did the surface. The heights over the central Pacific with the High were about 150 ft higher than normal. The Low over the Bering Sea was shifted eastward to near the Shumagin Islands.

The first tropical cyclone of the season for the eastern North Pacific, hurricane Aletta, formed on the 30th.

Extratropical Cyclones--The first significant storm this month formed on a degenerating stationary front between two cells of the Pacific High late on the 3d. The VERRAZANO BRIDGE (37°N, 163°W) contributed to the analysis with her 1800 report of measured 37-kn winds from the north-northeast with 26-ft waves. At 1200 on the 5th, the 994-mb LOW was squeezing northward between the two HIGHs and was near 42°N, 156°W. The PRESIDENT MONROE was west of the center with 40-kn winds and 15-ft waves. As she passed south of the center at 1800, the winds picked up to 50 kn and the swells to 25 ft. On the 6th there were more reports north and west of the center of winds over 40 kn. Among others the SEA-LAND EXCHANGE reported 45-kn winds near 53°N, 146°W. Buoy 46003 measured 45-kn winds. The waves were 15 to 20 ft. At 1200 the storm reached its lowest pressure of 976 mb. The PRESIDENT MONROE was now at 42°N, 152°W, with 45-kn winds, 20-ft seas, and 30-ft swells. The SHUNWIND was sailing eastward among the Aleutians with 40-kn winds and swells of 30 ft. On the 8th the storm dissipated over Alaska.

The eastern cell of the Pacific High was pushing tightly against the U.S. West Coast and the LOW over the Great Basin. The northerly winds increased along with the seas along the coast. On the 3d the HAWAIIAN QUEEN off San Francisco measured 40-kn winds and 13-ft seas. On the 4th the HAWAIIAN had 38-kn winds and 18-ft seas. The 5th saw the NANCY LYKES with 50-kn winds, 23-ft seas, and 33-ft swells south of Point Sur. The next day the seas and swells had increased by 2 ft. On the 7th the HIGH was pushed southwestward and the LOW retreated to Mexico loosening the gradient.

There were multiple LOW centers west of 170°W on the 6th. These partially consolidated on the 7th into two centers. The PRESIDENT POLK was southwest of the LOW with 40-kn winds and 20-ft seas and swells. At 0000 on the 8th this LOW had become the primary storm at 980 mb near 43°N, 173°W. Four ships had winds of 47 to 50 kn. Two of them reported waves over 30 ft near 41°N, 166°W. On the 9th the SANKOSUN (42°N, 167°W) had 40-kn winds with 30-ft swells. The OPHELIA was east of the occlusion with 68-kn southerly winds. The winds decreased on the 10th to gales as the storm entered the Gulf of Alaska and quickly deteriorated on the 11th.

A second center, east of Kamchatka, split off of a LOW that was over the Sea of Okhotsk on the 10th. A large HIGH was centered near 40°N, 180°, with a tight pressure gradient on the northwest side. A ship was sailing westward off Hokkaido in fog with 20-ft swells. On the 11th, the WORLD RUBY (47°N, 165°E) carried 45-kn winds from the southwest with 30-ft waves. On the 12th the 990-mb LOW was over the central Bering Sea. The MAMMOTH FIR was south of the LOW near 52°N, 172°W. The winds were only 40 kn, but they were whipping up 30-ft seas.

The HIGH had drifted to 36°N, 172°W, as the LOW stalled over the Bering Sea. The tight pressure gradient had rotated to north of the HIGH as the LOW moved. The TRIUMPH (49°N, 180°) was sailing into 30-kn winds and 26-ft swells near 49°N, 179°E, on the 13th.

On the 12th another LOW had formed to the east of

this one and was becoming the primary storm. Late on the 14th the original LOW dissolved on Alaska's west coast.

Monster of the Month--This was the LOW that broke away from the one above. At 0000 on the 13th the storm was 990 mb near 51°N, 155°W. The ATLAS CARRIER was west of the center with 25-ft swells. At 0000 on the 14th the observation of the JAPAN ACE at 43°N, 143°W, indicated a swell height of 49 ft. The winds were 40 kn and the seas 12 ft. The VAN ENTERPRISE was not far from that position (45°N, 143°W) at 1900, where she measured 37-kn winds from the west-northwest and 30-ft waves.

On the 15th the winds were in the 40-kn range. A SHIP near 37°N, 134°W, had 30-ft swells. As the LOW neared the Oregon coast, it rapidly filled and moved into the mountains.

Another cyclone born in the col area between two high-pressure areas. This one showed up on the analysis of 0000 on the 13th near 45°N, 168°E. On the 14th the GLADIOLUS was east of the cold front with following 45-kn winds. At 0000 on the 15th the 990-mb storm was slightly south of Unimak Island. A ship with the last three call letters of TOH was north of Unimak Island with 30-ft swells. The GRAND FELICITY had 44-kn winds near the dateline at 52°N. The PAN DYNASTI was far south of the storm near 42°N on the 16th with 34-ft swells. Another LOW was approaching from the west to move around the southern periphery. The GLADIOLUS and VAN ENTERPRISE now caught 50-kn winds, and the swells striking the PAN DYNASTI were only 28 ft. By the 17th this LOW had disappeared with the new one replacing it.

During the period of the 18th to the 26th a large HIGH with pressure generally above 1035 mb was entrenched off the U.S. West Coast near 43°N, 143°W. There were several ship reports during this period of northerly winds up to 50 kn and seas or swells up to 25 ft.

There had been a diffuse LOW over the Gulf of Alaska since the 25th. As it moved across the Alaska Peninsula late on the 24th, the MOBIL MERIDIAN had 45-kn winds and 18-ft waves west of Sitka. A frontal wave was moving eastward on the southern edge of its circulation, but it could not be identified on the 26th with the data available. On the 0000 chart of the 27th (The 0000 chart always has more reports.) a new LOW was identified near 50°N, 139°W. There were three other small centers across Alaska into the Yukon. The PACGLORY was 600 mi to the southwest with 40-kn winds. The CRESSIDA measured the same windspeed with 17-ft waves near 52°N, 139°W. Twenty-four hours later the 993-mb storm was near 56°N, 139°W. The GLADIOLUS was now at 51°N, 135°W, and reporting 65-kn winds with 13-ft seas and 16-ft swells. On the 28th the LOW moved over Valdez and drifted northeastward to disappear on the 29th.

The Pacific High again moved in close to the coast, and the tight gradient produced high winds and waves along the coast. The AUSTRAL MOON measured 50-kn winds and 30-ft seas and swells near Cape Mendocino on the 29th. On the 30th the winds increased to 55 kn. The AMERICAN CHAMPION was off San Francisco with 41-ft swells. Other ships reported winds in the gale category and waves in the 20-ft range.

Tropical Cyclones, Eastern Pacific--Hurricane Aletta came to life on the 30th south of Acapulco. Satellite photographs indicated that she was intensifying rapidly. Early the following day Aletta was upgraded to a hurricane as 65-kn winds blew around her center, which was meandering northwestward. At 1800 the KEYSTONER (16°N, 100°W) found 65-kn winds. At 0600 the next day the ALVA MAERSK had 35-kn winds near 17°N, 101°W. Neither ship reported waves. Aletta brushed the sparsely populated coast between Acapulco and Manzanillo on the 31st. This caused her to weaken. When the main center moved ashore, a second center developed and briefly intensified. However, she quickly lost her strength. By June 1 she had degenerated to an area of active thunderstorms with little detectable circulation.

Casualties--The 19,734-ton Liberian-registered bulk-carrier SUMMIT VENTURE was at Nagoya on the 18th requesting a survey for heavy weather damage from a voyage from Hampton Roads and Los Angeles.

SMOOTH LOG, JUNE 1978--Storms over this ocean were few and shifted to the west. Climatology shows the primary storm path is from Kyushu east-northeastward to the central ocean and then into the Gulf of Alaska. At midocean a branch turns northward into the Bering Sea. This month the primary track was from an area about 400 mi east of Honshu northeastward into the Bering Sea. A secondary track left the same area, but tracked eastward then turned northeastward to the Alaska Peninsula. Early in the month one LOW tracked from south of Kyushu to Vancouver Island, taking 12 days.

The Pacific High was, by far, the most dominant feature on the mean sea-level pressure chart. The 1030-mb center at 40°N, 155°W, was 6 mb higher than the climatological center and about 600 mi northwest of its climatic position. A ridge extended northward to the southern coast of Alaska. The 1010-mb climatic Aleutian Low, which is normally north of Adak Island, did not exist. Rather, there were four small LOW centers surrounding the Sea of Okhotsk. The lowest was 1003 mb over Siberia northwest of the Sea of Okhotsk.

The differences in pressure and location of the surface centers resulted in two major large anomaly centers. The largest, and probably the most significant as far as the mariner was concerned, was a posi-

tive 11 mb near 45°N, 158°W. In general, this positive anomaly area covered the major portion of the ocean from 20°N to Alaska and coast to coast east-west. The exception to this was an area of negative values with a minus 8-mb center over the Kamchatka Peninsula. This area included most of the Bering Sea, the Sea of Okhotsk, and Hokkaido.

The upper air pattern had a closer resemblance to climatology. At 700 mb the High was centered northwest of Hawaii about 800 mi west of its usual position and 10 m higher. The Low was shifted northwestward over the Siberian coast, rather than north of Adak Island as per climatology. The height was about 47 m lower than the climatological mean. There were the usual troughs paralleling the coastlines with a ridge over Alaska.

There were six tropical cyclones, three on each side of the dateline. In the eastern Pacific there were tropical storm Bud and hurricanes Carlotta and Daniel. The western Pacific experienced tropical storms Polly, Rose, and Shirley.

Extratropical Cyclones--Monster of the Month--The East China Sea spawned this storm on the 2d. It was an especially long-lived storm for this time of year, lasting until it reached Vancouver Island on the 14th. The SEALAND EXCHANGE was involved almost immediately with gales of 35 kn east of the center. The storm passed south of Japan on the 3d and 4th bringing heavy rains to the Islands. On the 5th the 984-mb LOW was near 45°N, 152°E. There were many reports of gales. The JUNEAU MARU found 45-kn winds and 16-ft seas east of the center near 44°N, 156°E. The PRESIDENT JOHNSON (42°N, 150°E) was pounded by 25-ft swells, while the ILLINOIS (39°N, 154°E) had 20-ft seas. On the 6th the YOZAN MARU (44°N, 154°E) was sail ing into 44-kn westerly winds with 21-ft waves. At 1200 the 976-mb storm was near 50°N, 160°E. The NORDKAP and SHIN SHIEN both had 45-kn winds south of the center with waves up to 20 ft. Gale-force winds continued into the 7th, when the storm entered the Bering Sea.

As it crossed the colder waters of the Bering Sea, it weakened; but the westerly winds from its circulation extended south of latitude 45°N. On the 10th the PRESIDENT VAN BUREN was in the warm sector of the frontal system (42°N, 139°W) and reported 50-kn southwesterly winds. The storm was now tracking southeastward across the Gulf of Alaska. By the 12th it was idling off the coast of British Columbia. A ship beneath the upper air trough was hit by 45-kn northwesterlies. At this time the LOW was only 1008 mb. On the 14th the storm was headed toward the Strait of Juan de Fuca and rapidly dissipating.

This storm was the second of two that reached the North American coast, excluding Alaska. This one developed as a wave on a weak front that had penetrated the Pacific High. It was first found on the 3d about midway between Hawaii and Seattle. Late that day the FEDSTEEL was near 40°N, 153°W, northwest of the LOW. Her winds were 43 kn and seas 13 ft. Twelve hours later as she moved westward and the storm moved northward, the winds were 48 kn. At 0000 on the 5th the 1000-mb storm was near 40°N, 143°W. The TRANSCHAMPLAIN had just penetrated the front with 35-kn winds. A ship northwest of the center had 40-kn gales. Later on the 5th the VIOLET northwest of the center reported 36-kn gales. The storm continued to move northward until the 8th, when it suddenly turned southeastward and the high-pressure cell off the California coast gave way to its continued pressure. On the 9th the center crossed Vancouver Island and disintegrated.

As a LOW and associated front moved over the Asian coast on the 11th, the LOW stalled and the front broke away and continued to move. At 1200 another LOW had formed at the occlusion north of Hokkaido. Heavy rains fell on Kyushu flooding 600 homes and roads and railways. Up to 11 in of rain fell in 24 hr. The FEDSTEEL was south of the front (37°N, 147°E) on the 12th with 43-kn winds from the south-southwest. The 998-mb LOW was racing eastward under upper air zonal flow. On the 13th it caught up with a LOW centered over the Bering Sea and moved south of it. On the 14th the JAPAN ACE (42°N, 175°W) and a SHIP (46°N, 171°W) both had 40-kn winds from 200° just east of the cold front. The CHEVRON WASHINGTON found 17-ft swells at 54°N, 160°W. At this time the LOW turned sharply northward and absorbed the circulation of the LOW over the Bering Sea. By the 15th the storm had crossed the Alaska Peninsula and was over western Alaska. The pressure gradient appeared like it would have supported gale-force winds, but none were reported. The storm entered the Bering Strait on the 16th and died.

This LOW appeared in the vicinity of the Near Islands on the 15th. It moved northward prior to turning eastward late on the 16th. The VAN WARRIOR was sailing northeastward near 49°N, 170°W, with 35-kn southerly winds. A SHIP in the East Siberian Sea found 40-kn easterly winds off Mys. Shelagskiy. The JAPAN RAINBOW found 50-kn winds out of the west-southwest on the 17th near 54°N, 164°W. Several ships found 35- to 40-kn gales with one measuring seas of 20 ft. On the 18th the LOW was headed northward through the Bering Strait.

The Pacific High gradually had built to 1038 mb by the 14th. The pressure gradient along the U.S. West Coast was increasing as were the northerly winds. At this time the heat LOW over the Great Basin was weak. By the 18th the central pressure had built to 1042 mb near 45°N, 145°W. Two SHIPs reported 35 kn off Seattle. The PHILADELPHIA was on the northwest side of the HIGH on the 18th and 19th with winds under 30 kn, but the swells were 25 ft out of the southwest.

On the 19th the PORTLAND found 45-kn winds, and the S.P. LEE had 38-kn winds and 20-ft waves off Vancouver Island. Farther south the TOYOTA MARU out of San Francisco radioed 62-kn winds. On the 20th the ORIENTAL SOVERIGN and PACSTAR found winds in the 40-kn range off Seattle. The HIGH was slipping slowly westward, and without a strong heat LOW the winds did not develop as they do at times with a weaker HIGH. On the 23d the YING YUNG was on the Great Circle track out of Seattle and headed into 21-ft swells. That day the pressure dropped below 1040 mb, and the center drifted slightly westward, easing the gradient along the coast.

Weak LOWs had been running up the west side of the Pacific High but had not made much headway against it. On the 20th one of these produced high winds and seas for a reporting ship. The PACIFIC VENTURE (43°N, 167°W) measured 46-kn winds and 23-ft seas. On the 21st a LOW was found east of Hokkaido. On the 23d it was 996 mb near 45°N, 172°E. Only near gales were being reported. On the 26th the storm was over Kodiak Island. A SHIP near 52°N, 137°W, had 45-kn winds. Later in the day another LOW developed over interior Alaska and then dissipated into only a trough. The last days of the month the Pacific High again became the major influence and dominated the eastern two-thirds of the ocean. The CHEVRON WASHINGTON was off Cape Mendocino on the 26th and measured 47-kn winds driving 12-ft seas.

Tropical Cyclones, Eastern Pacific--Tropical storm Bud and hurricane Carlotta both began on the 17th. Bud developed about 550 mi west of Clipperton Island, while Carlotta formed about 230 mi to the northeast of the Island. Both moved on a general west-northwesterly track. Carlotta reached hurricane strength on the 19th just before crossing the 115th meridian, while Bud became a tropical storm on the 17th and hit a peak intensity of 55 kn on the 19th after crossing the 125th meridian. The DEEPSEA MINER II measured 37-kn winds and 13-ft seas late on the 18th at 14.6°N, 125.3°W. Bud degenerated rapidly after that and was a weak depression by the 20th. Carlotta, however, had just begun. Maximum winds near her center rose to 105 kn on the 20th and to 115 kn by the 21st. At this time she was spotted approaching the 120th meridian near 14°N. Winds remained above 100 kn for another day, but then Carlotta began to cool. She fell below hurricane strength on the 24th just past 125°W. By the 25th Carlotta was a depression.

Daniel appeared on the 26th near 13°N, 100°W. He moved west-northwestward until reaching 107°W on the 28th, and then he headed westward for the next 5 days. This journey covered a distance of some 2,000 mi. Daniel achieved hurricane strength on the 29th as he cruised 120 mi to the south of Socorro and the Clarion Island. As he passed south of Clarion, winds near his center hit 100 kn (fig. 67). Daniel maintained this intensity for 2 days, but on July 2 he began to weaken. The following day he fell to depression strength after crossing 135°W near 17°N.

Tropical Cyclones, Western Pacific--Tropical-cyclone activity was nill during the first half of June. In the second half of the month three weak, short-lived tropical storms--Polly, Rose, and Shirley--developed in the Philippine Sea-South China Sea region. On the 17th Polly formed about 150 mi southeast of Okinawa. She moved northwestward through the Ryukyu Islands and attained tropical-storm strength the following day. Maximum winds reached 50 kn on the 19th. The SEA-LAND TRADE nearly matched that with 49 kn at 1800 near 29°N, 127°E. Her seas were 20 ft and she registered a pressure of 989.5 mb. However, Polly was recurving by this time and was prevented from further intensification when she ran afoul of Kyushu on the 20th. The rugged island caused her to weaken rapidly.

Rose encountered a similar problem with Taiwan on the 24th. She had come to life about 120 mi east of northern Luzon on the 23d. Winds climbed to 40 kn late in the day, but before she could really get up a head of steam, Rose slammed into Taiwan and died. Shirley's fate was almost predetermined when she blossomed just 120 mi east of Vietnam on the last day of the month. She managed to generate 45-kn winds before running aground near Qui-nhon before the day was out.

Casualties--Fog was the real culprit this month. All known weather casualties involved fog. The 1,570-ton Korean GLOBAL EXPORTER sank after a collision in fog with the 19,924-ton Japanese EIRYA MARU on the Inland Sea on the 15th. All the crew was rescued. The 99-ton tuna fishing boat YURYO MARU and the Taiwanese freighter CHEN CHANG (4,995 tons) collided in fog off Iwate Prefecture on the 21st. The YURYO MARU capsized and only 2 of the 16 crewmen were rescued. Two ferries collided off Awaji Island in the Inland Sea on the 26th in dense fog. They were the 1,758-ton HAYABUSA No. 2 and the 1,608-ton HAYABUSA No. 5. Five persons were injured.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

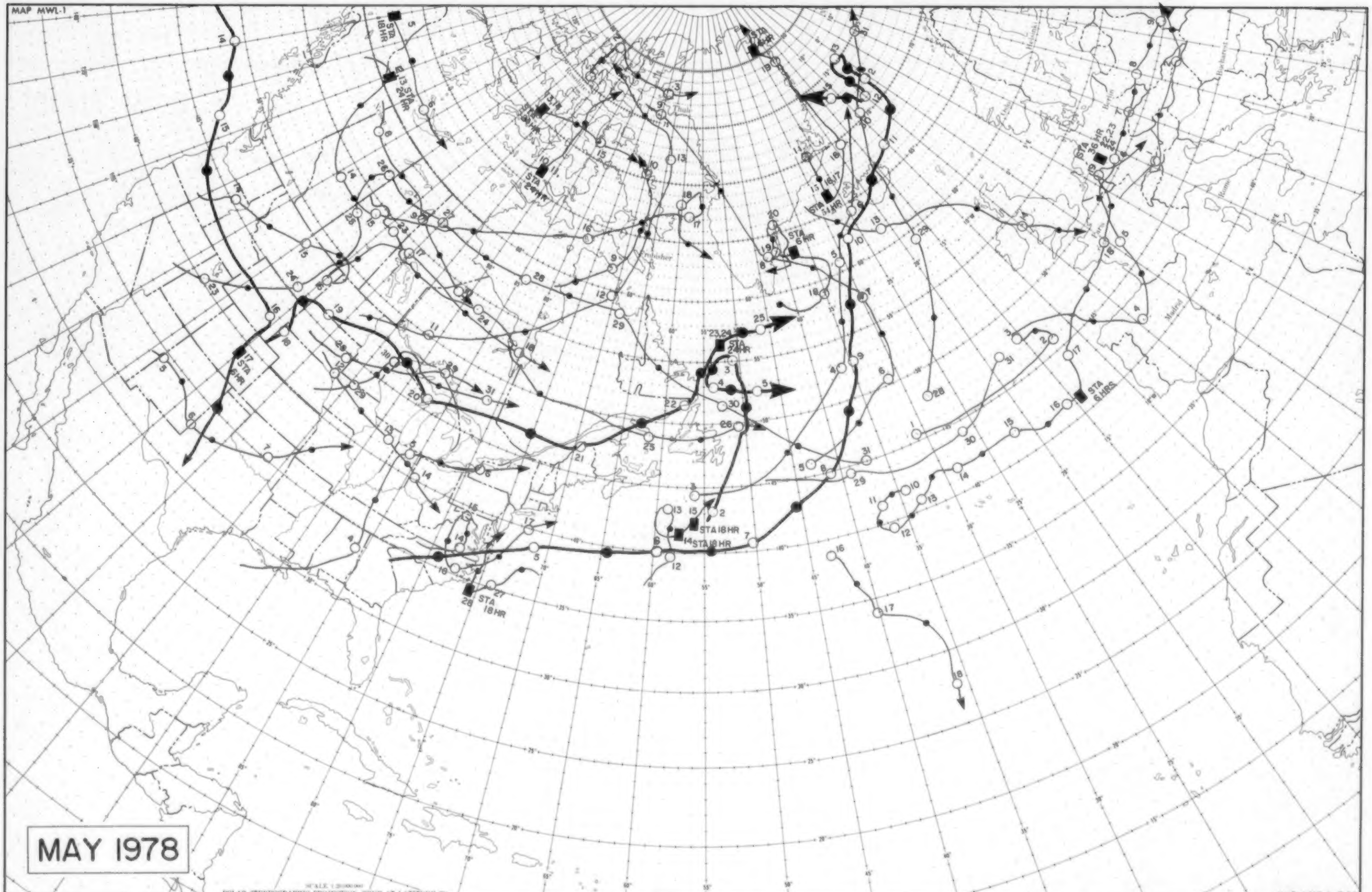


Figure 41. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

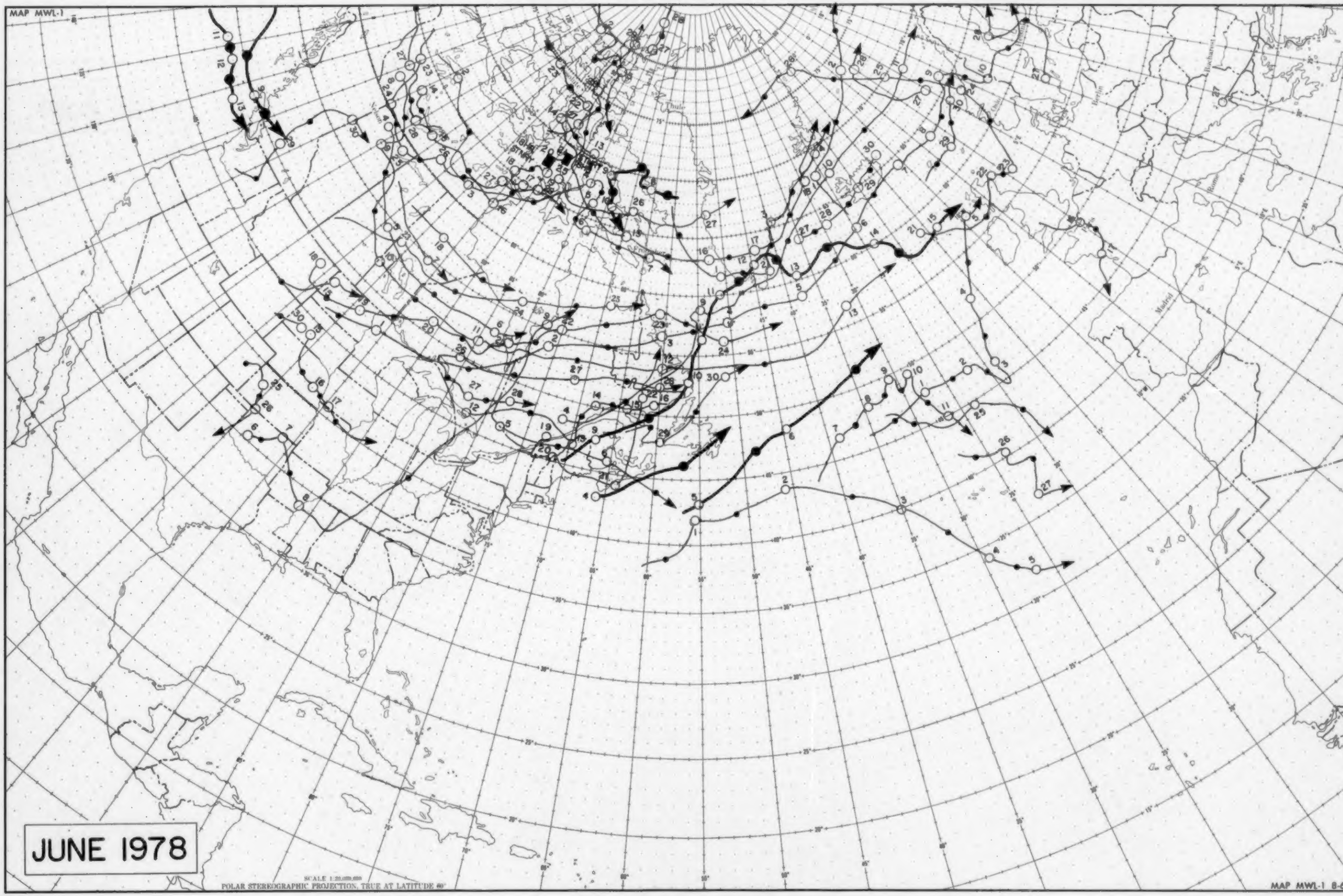


Figure 42.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

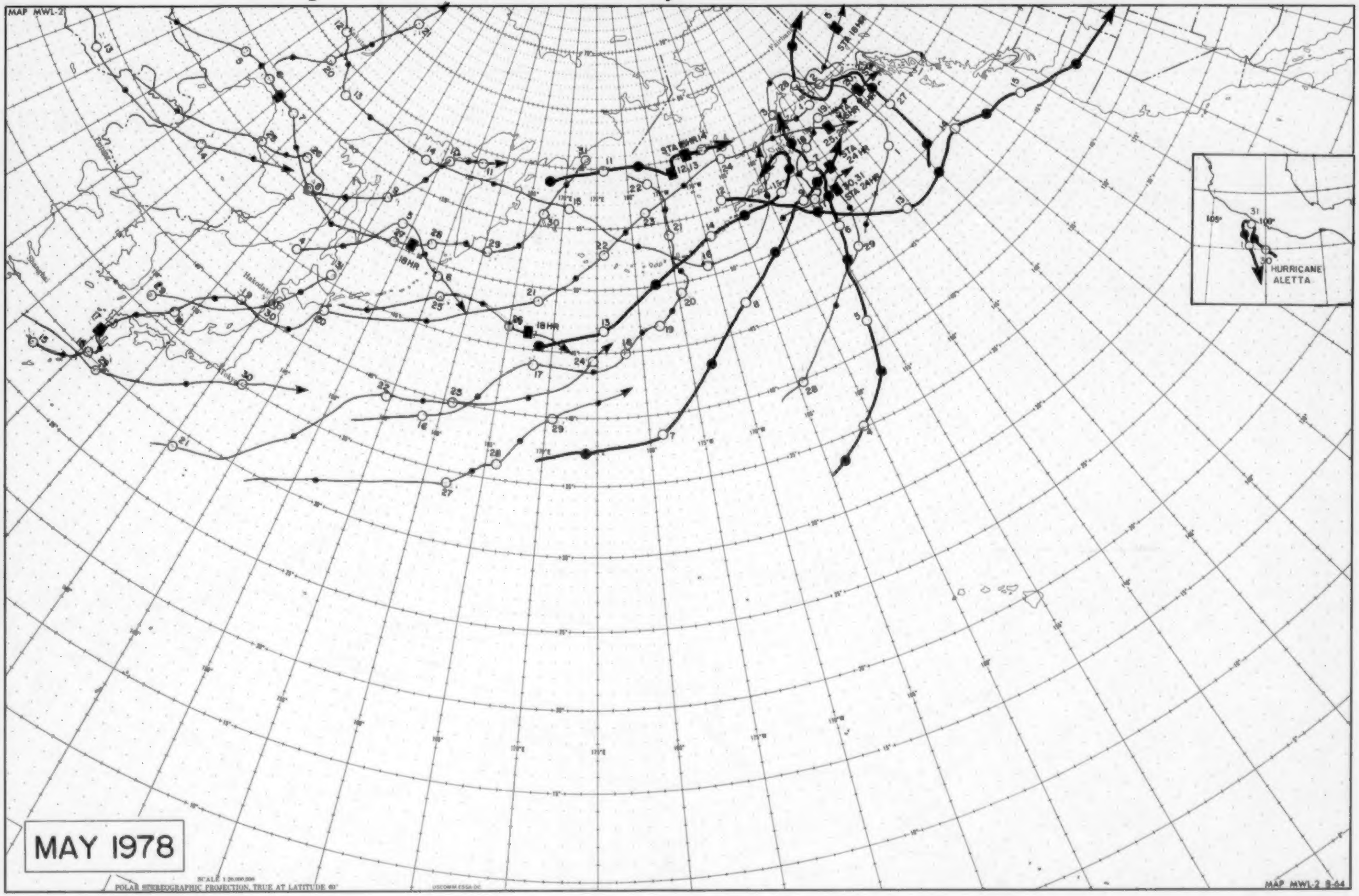


Figure 43. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

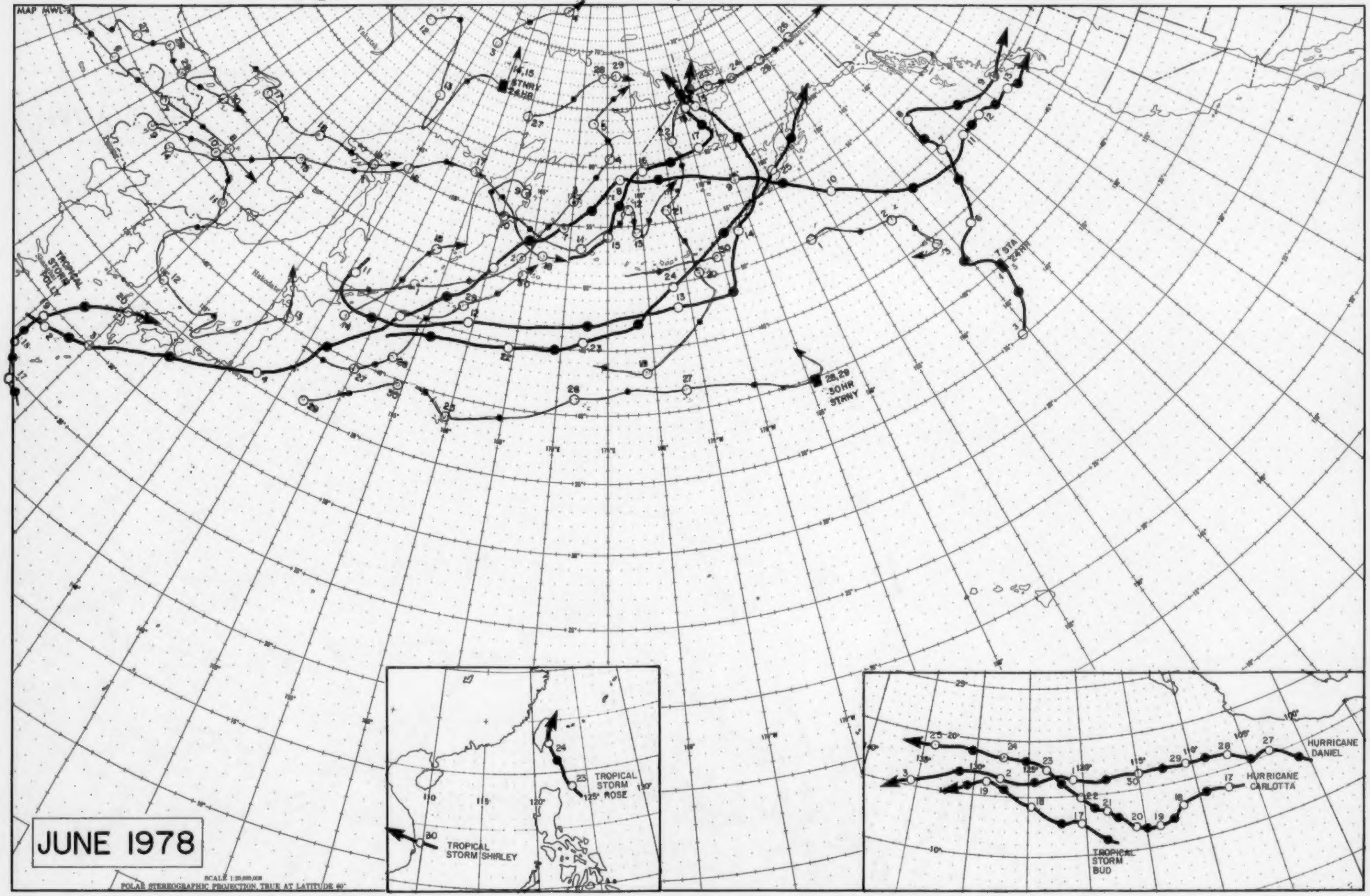


Figure 44. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 8
U.S. Ocean Buoy Climatological Data
May and June 1978

MAY — D A T A S U M M A R Y — 41001

AVERAGE LATITUDE 35.0N — AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	13.8	(02 08)	18.7	24.3	(31 21)	245	31
SEA TEMP (DEG C)	16.9	(08 00)	20.5	25.3	(31 21)	246	31
AIR-SEA TEMP (DEG C)	-05.8	(02 08)	-01.8	01.8	(06 08)	246	31
PRESSURE (MBAR)	1004.2	(01 21)	1016.4	1027.2	(12 16)	246	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 245

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.4	4.1	6.9	1.2			14.7	11.4
NE		2.0	1.2				3.3	11.0
E	.8	1.6	4.1				6.5	10.6
SE	.4	6.9	10.6	.8			18.8	12.7
S	1.2	4.1	14.7	5.7			25.7	15.6
SW	.4	2.4	8.6	.4			11.8	13.8
W	.8	2.6	3.7				7.3	10.8
NW	1.2	3.3	6.5				11.0	11.3
CALM	.8						.8	.0
TOTAL	8.2	27.3	56.3	8.2			100.0	12.8

MAX WIND — SPEED: 33 KNOTS — DIRECTION: 180 DEG — DAY: 10 — HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 245

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	1.6	73.8	20.0	4.1	.4				1.5M	4.0M	(10 09)

MAY — D A T A S U M M A R Y — 41002

AVERAGE LATITUDE 32.3N — AVERAGE LONGITUDE 075.3W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	16.4	(03 06)	21.5	26.4	(30 18)	248	31
SEA TEMP (DEG C)	19.8	(01 08)	23.3	25.4	(28 21)	248	31
AIR-SEA TEMP (DEG C)	-05.5	(03 06)	-01.8	02.6	(30 18)	248	31
PRESSURE (MBAR)	1006.5	(02 06)	1017.1	1026.6	(12 15)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 246

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		3.8	2.8				6.7	10.6
NE	.8	4.9	4.1				9.8	9.9
E		4.9	4.8				9.8	10.1
SE	1.6	5.7	5.7	1.6			14.6	11.8
S	.4	8.1	7.3	4.5			20.3	14.6
SW	.4	7.3	8.1	6.1			22.0	15.2
W	1.2	3.7	5.3	.4			10.6	11.0
NW	.4	2.4	4.1				6.9	10.1
CALM	.4						.4	.0
TOTAL	5.3	38.8	42.3	12.6			100.0	12.4

MAX WIND — SPEED: 28 KNOTS — DIRECTION: 180 DEG — DAY: 14 — HOUR: 08

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 245

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	16.3	64.8	17.8	.8	.4				1.3M	4.5M	(09 08)

MAY — D A T A S U M M A R Y — 42001

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 090.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	22.0	(05 08)	25.6	27.7	(31 21)	247	31
SEA TEMP (DEG C)	22.4	(04 08)	25.3	28.2	(31 21)	228	31
AIR-SEA TEMP (DEG C)	-01.5	(18 03)	00.3	02.0	(08 15)	228	31
PRESSURE (MBAR)	1000.8	(04 00)	1013.4	1021.8	(11 15)	247	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 246

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		2.0	1.2				3.3	9.8
NE	.8	8.9	.4				10.2	6.9
E	1.2	22.4	3.3				26.9	7.3
SE	2.0	14.2	16.3				32.5	10.2
S	.8	8.1	11.4	.8			21.1	11.7
SW		.8					.8	6.5
W								
NW		3.7	1.6				5.3	9.3
CALM								
TOTAL	4.9	60.2	34.1	.8			100.0	9.3

MAX WIND — SPEED: 23 KNOTS — DIRECTION: 170 DEG — DAY: 03 — HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	44.1	41.9	14.0						1.0M	2.5M	(08 19)

MAY — D A T A S U M M A R Y — 42002

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 093.5W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	20.6	(04 12)	24.9	27.3	(31 18)	245	31
SEA TEMP (DEG C)	22.7	(04 15)	25.0	28.0	(31 21)	244	31
AIR-SEA TEMP (DEG C)	-02.7	(04 21)	-00.1	01.5	(07 12)	244	31
PRESSURE (MBAR)	1000.0	(03 21)	1011.5	1018.6	(14 15)	243	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 244

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		2.5	1.6				4.1	9.4
NE		3.3	.8				4.1	7.6
E	1.6	30.3	7.0				38.9	8.1
SE	1.6	15.6	25.8				43.0	11.1
S	.4	4.5	2.0				7.0	8.7
SW	.4						.4	2.0
W	.4	.4	.4				1.2	6.4
NW	.4		.8				1.2	13.0
CALM								
TOTAL	4.9	55.6	38.5				100.0	9.9

MAX WIND — SPEED: 19 KNOTS — DIRECTION: 120 DEG — DAY: 07 — HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 236

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	33.5	53.8	12.7						1.1M	2.5M	(07 21)

MAY — D A T A S U M M A R Y — 42003

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 086.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	23.0	(05 08)	25.8	27.8	(31 21)	241	31
SEA TEMP (DEG C)	21.2	(08 06)	25.9	28.5	(31 21)	238	31
AIR-SEA TEMP (DEG C)	-01.8	(22 18)	-00.1	03.8	(04 12)	238	31
PRESSURE (MBAR)	1003.2	(04 09)	1014.2	1021.1	(11 15)	243	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 243

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	1.6	.8				3.3	7.4
NE	1.2	9.9	1.2				12.3	7.7
E	.8	27.6	18.9				47.3	8.6
SE	2.5	11.1	5.8				18.3	8.6
S	.4	4.9	4.1				9.5	10.2
SW	.4		.4				.8	5.5
W		1.2	.4				1.6	8.0
NW	.4	3.7	1.6				5.8	8.8
CALM								
TOTAL	6.6	60.5	32.9				100.0	8.1

MAX WIND — SPEED: 21 KNOTS — DIRECTION: 170 DEG — DAY: 18 — HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 229

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	53.8	38.1	5.8	2.2					.9M	3.0M	(04 21)

JUNE — D A T A S U M M A R Y — 41001

AVERAGE LATITUDE 35.0N — AVERAGE LONGITUDE 072.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	18.5	(15 09)	23.8	28.2	(30 21)	238	30
SEA TEMP (DEG C)	21.8	(08 09)	23.8	27.2	(26 21)	238	30
AIR-SEA TEMP (DEG C)	-04.4	(15 08)	-00.0	01.0	(10 00)	238	30
PRESSURE (MBAR)	1006.4	(04 18)	1016.7	1029.4	(17 15)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 238

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.3	3.3	6.4	.4			10.9	11.8
NE	.4	5.8	7.1				13.4	10.7
E	.8	4.6	2.1				7.6	8.0
SE	2.1	2.1	.4				4.6	4.4
S	1.3	13.0	16.3	.4			31.0	11.8
SW	.4	5.0	13.4				18.7	11.5
W		3.3	.4				3.8	6.8
NW	1.3	3.3	2.1				6.7	7.3
CALM	2.9						2.9	.0
TOTAL	10.9	41.4	47.3	.8			100.0	10.0

MAX WIND — SPEED: 34 KNOTS — DIRECTION: 340 DEG — DAY: 04 — HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	20.1	77.4	2.9						1.0M	2.0M	(10 09)

JUNE — D A T A S U M M A R Y — 41002

AVERAGE LATITUDE 32.3N — AVERAGE LONGITUDE 075.3W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	21.0	(18 08)	23.9	28.8	(30 21)	238	30
SEA TEMP (DEG C)	23.6	(08 09)	25.6	28.4	(30 21)	238	30
AIR-SEA TEMP (DEG C)	-05.4	(14 09)	-01.6	00.8	(01 12)	238	30
PRESSURE (MBAR)	1010.8	(04 15)	1015.1	1020.0	(17 15)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 238

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		1.7	1.7				3.4	10.9
NE	.4	2.9	10.1	.4			13.8	13.8
E	.4	6.3	10.5				17.2	11.9
SE	.4	7.1	7.6				15.1	10.8
S	1.7	8.3	7.6				18.6	10.1
SW	.4	9.2	8.8	.4			18.8	11.6
W		9.2	4.2				13.4	9.9
NW	.8	.8	.4	.4			2.5	9.2
CALM								
TOTAL	4.2	45.7	50.8	1.3			100.0	11.2

MAX WIND — SPEED: 24 KNOTS — DIRECTION: 310 DEG — DAY: 10 — HOUR: 08

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 237

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	23.6	75.1	1.3						1.0M	2.0M	(19 12)

JUNE — D A T A S U M M A R Y — 42001

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE [illegible]

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	22.6	(08 21)	27.5	28.9	(28 00)	240	30
SEA TEMP (DEG C)	27.0	(28 21)	27.6	28.4	(27 00)	140	26
AIR-SEA TEMP (DEG C)	-02.8	(18 21)	-00.2	01.1	(30 21)	140	26
PRESSURE (MBAR)	1011.3	(08 08)	1016.7	1020.1	(28 15)	240	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 237

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	3.4	3.0					6.3	4.0
NE	2.1	7.2	1.7				11.0	6.7
E	3.8	27.8	10.1				41.8	7.7
SE	3.4	21.5	4.6				29.5	7.2
S	.8	3.8	3.0				7.6	8.2
SW	.4	.8					1.3	3.7
W	.8						.8	2.1
NW	1.3						1.3	2.0
CALM	.4						.4	.0
TOTAL	16.5	64.1	19.4				100.0	7.0

MAX WIND — SPEED: 19 KNOTS — DIRECTION: 080 DEG — DAY: 18 — HOUR: 21

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 229

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	51.1	44.1	4.8						.9M	2.0M	(18 15)

JUNE — D A T A S U M M A R Y — 42002

AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 093.5W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	24.0	(04 03)	27.7	28.9	(28 00)	230	30
SEA TEMP (DEG C)	27.1	(04 08)	28.4	29.6	(29 21)	230	30
AIR-SEA TEMP (DEG C)	-04.3	(18 21)	-00.7	00.4	(06 15)	230	30
PRESSURE (MBAR)	1008.6	(08 00)	1015.7	1020.4	(13 15)	230	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 230

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	2.9	1.3				4.6	8.3
NE	.4	8.8	1.7				10.9	7.5
E	1.3	22.6	7.1				31.0	8.6
SE	2.9	17.6	13.0				33.5	8.5
S		10.9	3.8				14.6	8.2
SW	1.7		.4				2.1	4.8
W	1.3						1.3	2.4
NW	.4	1.7					2.1	7.4
CALM								
TOTAL	8.4	64.4	27.2				100.0	8.7

MAX WIND — SPEED: 19 KNOTS — DIRECTION: 140 DEG — DAY: 07 — HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 231

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	43.7	55.9	.4						.9M	2.0M	(07 09)

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AVERAGE LATITUDE 26.0N — AVERAGE LONGITUDE 086.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	23.5	(05 03)	27.6	29.4	(08 21)	236	30
SEA TEMP (DEG C)	25.7	(21 12)	28.1	30.0	(26 21)	234	30
AIR-SEA TEMP (DEG C)	-04.2	(08 03)	-00.5	03.2	(04 21)	234	30
PRESSURE (MBAR)	1013.6	(01 09)	1017.0	1020.8	(17 18)	236	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 234

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	3.4	7.7	2.6				13.7	7.1
NE	.4	5.6	3.4				9.4	9.5
E	2.1	20.9	12.4				35.5	9.2
SE	.9	13.7	4.3				18.9	8.8
S	1.3	7.3	1.3				9.8	8.0
SW	.4	2.1					2.6	7.3
W	.4	2.6					3.0	6.7
NW	.9	5.1	1.3				7.3	7.6
CALM								
TOTAL	9.9	65.0	25.2				100.0	8.5

MAX WIND — SPEED: 18 KNOTS — DIRECTION: 080 DEG — DAY: 19 — HOUR: 12

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 228

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	58.4	36.2	4.4						.9M	2.0M	(20 21)

MAY DATA SUMMARY 44002
AVERAGE LATITUDE 40.1N AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	03.8	(09 08)	08.7	17.1	(23 18)	230	31
SEA TEMP (DEG C)	06.4	(01 08)	08.7	14.3	(31 00)	216	31
AIR-SEA TEMP (DEG C)	-03.3	(28 08)	01.0	05.1	(23 18)	216	31
PRESSURE (MBAR)	1001.0	(05 09)	1015.1	1028.0	(09 10)	215	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 198

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.0	5.1	2.5				9.6	7.6
NE	1.5	4.0	8.1	1.5			15.2	12.5
E	1.0	6.1	5.1	.5			13.6	10.0
SE	.5	6.1	5.1				11.6	9.9
S	1.0	7.6	5.1	.5			14.1	9.8
SW	.5	12.6	2.0				15.2	7.9
W	2.0	6.1	1.0				9.1	6.9
NW	.5	3.0	4.5				8.1	11.4
CALM	.5						.5	.0
TOTAL	8.6	53.5	34.3	3.5			100.0	9.6

MAX WIND
SPEED: 27 KNOTS
DIRECTION: 040 DEG
DAY: 05
HOUR: 09

MAY DATA SUMMARY 44003
AVERAGE LATITUDE 40.8N AVERAGE LONGITUDE 068.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	04.3	(01 09)	08.1	11.8	(25 00)	198	28
SEA TEMP (DEG C)	05.5	(02 12)	06.6	07.6	(31 18)	198	28
AIR-SEA TEMP (DEG C)	-01.3	(02 09)	01.5	05.1	(10 09)	198	28
PRESSURE (MBAR)	1000.7	(03 00)	1019.1	1028.6	(12 15)	193	28

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 195

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.5	5.6	.5				7.7	8.8
NE	.5	6.7	2.6	.5			10.3	8.8
E	3.6	8.7	8.7	1.0			22.1	11.1
SE	1.5	10.8	1.5				13.8	7.0
S	2.1	3.6					5.6	4.8
SW	3.1	8.7	2.1				14.9	8.8
W	2.6	8.7	8.7				20.0	8.8
NW		3.6	2.1				5.6	8.8
CALM								
TOTAL	13.8	57.4	27.2	1.5			100.0	8.4

MAX WIND
SPEED: 25 KNOTS
DIRECTION: 060 DEG
DAY: 05
HOUR: 21

MAY DATA SUMMARY 44004
AVERAGE LATITUDE 38.5N AVERAGE LONGITUDE 070.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	06.0	(02 06)	15.5	22.3	(29 21)	246	31
SEA TEMP (DEG C)	14.6	(14 09)	17.5	22.5	(29 21)	245	31
AIR-SEA TEMP (DEG C)	-08.9	(02 09)	-02.0	02.0	(18 21)	245	31
PRESSURE (MBAR)	0999.0	(06 12)	1019.0	1027.0	(09 18)	246	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 246

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	7.3	4.9	.8			13.8	10.6
NE		2.4	5.7	.4			8.5	12.5
E		4.9	5.7	.8			11.4	13.4
SE	2.4	6.5	7.3	.8			17.1	10.5
S	.4	6.5	4.5	1.6	1.6		15.0	14.7
SW		4.1	3.3	.4			7.7	13.0
W	1.2	3.3	8.3	1.2			19.0	13.3
NW	.4	4.5	6.5				11.4	11.6
CALM								
TOTAL	5.3	37.4	50.0	5.7	1.6		100.0	12.4

MAX WIND
SPEED: 37 KNOTS
DIRECTION: 180 DEG
DAY: 10
HOUR: 00

MAY DATA SUMMARY 46001
AVERAGE LATITUDE 56.0N AVERAGE LONGITUDE 148.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	03.1	(08 06)	04.8	07.4	(27 00)	248	31
SEA TEMP (DEG C)	04.3	(08 06)	05.0	06.8	(27 06)	248	31
AIR-SEA TEMP (DEG C)	-01.6	(13 03)	00.0	01.6	(27 00)	248	31
PRESSURE (MBAR)	0990.7	(21 18)	1010.3	1030.2	(31 00)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 248

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		1.2	.8				2.0	8.4
NE	.4	1.2	2.8				4.4	9.8
E	.4	4.0	6.5	4.0	.8		16.1	15.8
SE	1.2	1.6	8.7	6.5			18.0	17.8
S	1.2	4.8	14.1	1.2			21.4	14.5
SW	.8	2.4	22.1				25.4	13.4
W	.4	1.6	7.3	3.2			12.5	15.7
NW		2.4	.4				2.8	9.1
CALM	1.2						1.2	.0
TOTAL	6.0	20.2	58.1	14.9	.8		100.0	14.5

MAX WIND
SPEED: 38 KNOTS
DIRECTION: 080 DEG
DAY: 06
HOUR: 08

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY		32.4	45.3	16.6	5.5				2.2M	5.5M	(06 12)

MAY DATA SUMMARY 46002
AVERAGE LATITUDE 42.5N AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.4	(09 15)	11.2	13.3	(13 00)	244	31
PRESSURE (MBAR)	1000.7	(16 12)	1025.6	1033.6	(28 06)	244	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 244

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	8.2	22.1	9.4			40.2	16.2
NE		2.0	2.5				4.5	14.0
E	.4	1.2					1.6	5.0
SE		1.2					1.2	8.0
S			2.0	1.2			3.3	18.4
SW		.4	7.8	3.7			11.8	17.8
W	.4	2.5	8.6	.8			12.3	14.1
NW		3.7	18.9	1.6			24.2	14.7
CALM	.8						.8	.0
TOTAL	2.0	18.3	61.9	18.8			100.0	15.3

MAX WIND
SPEED: 27 KNOTS
DIRECTION: 170 DEG
DAY: 12
HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 244

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	3.3	28.0	53.7	13.5	4.5				2.2M	5.0M	(15 18)

MAY DATA SUMMARY 46003
AVERAGE LATITUDE 52.0N AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	01.9	(08 03)	04.2	06.2	(23 06)	248	31
SEA TEMP (DEG C)	03.6	(01 15)	04.3	05.1	(28 06)	247	31
AIR-SEA TEMP (DEG C)	-01.8	(15 00)	-00.1	01.5	(23 06)	247	31
PRESSURE (MBAR)	0986.3	(08 18)	1007.4	1034.5	(20 18)	248	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 248

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	1.6	1.2	1.2	.4		4.8	15.1
NE		.4	2.8	.8	.4		4.4	18.0
E		1.2	1.2				2.4	10.8
SE		.8	4.0	.8			5.6	15.8
S	.4	1.2	10.9	2.8			15.3	15.8
SW	.4	1.6	9.7	8.8			20.6	18.0
W		7.3	26.2	2.8			36.3	14.3
NW	.4	3.6	4.0	2.0			10.1	13.7
CALM	.4						.4	.0
TOTAL	2.0	17.7	60.1	18.4	.8		100.0	15.6

MAX WIND
SPEED: 39 KNOTS
DIRECTION: 030 DEG
DAY: 08
HOUR: 00

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 247

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	1.2	30.7	40.8	18.8	8.0	.4			2.3M	6.5M	(08 15)

JUNE DATA SUMMARY 44002
AVERAGE LATITUDE 40.1N AVERAGE LONGITUDE 073.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	12.7	(14 12)	17.2	22.8	(30 21)	227	30
SEA TEMP (DEG C)	12.4	(06 08)	16.4	20.7	(30 21)	223	30
AIR-SEA TEMP (DEG C)	-02.4	(14 08)	00.8	03.1	(02 00)	223	30
PRESSURE (MBAR)	1005.5	(09 18)	1016.4	1028.5	(17 15)	226	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 217

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.4	.9	.9				3.2	7.8
NE		.5					.5	6.0
E	.5	1.4					1.8	4.5
SE	1.4	8.8	.5				10.6	6.5
S		27.6	14.7				42.4	9.7
SW	.9	6.0	4.6				11.5	9.4
W	.9	14.7	5.5	1.4			22.6	9.4
NW	.9	4.1	2.3				7.4	7.5
CALM								
TOTAL	6.0	64.1	28.6	1.4			100.0	9.0

MAX WIND
SPEED: 24 KNOTS
DIRECTION: 280 DEG
DAY: 14
HOUR: 06

JUNE DATA SUMMARY 44003
AVERAGE LATITUDE 40.8N AVERAGE LONGITUDE 068.5W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	07.8	(01 00)	11.8	15.2	(26 18)	124	20
SEA TEMP (DEG C)	07.3	(01 00)	08.5	11.8	(28 18)	122	20
AIR-SEA TEMP (DEG C)	-00.1	(26 03)	02.3	04.8	(27 12)	121	20
PRESSURE (MBAR)	1005.8	(30 06)	1017.5	1031.2	(17 15)	124	20

JUNE DATA SUMMARY 44004
AVERAGE LATITUDE 38.5N AVERAGE LONGITUDE 070.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	14.9	(14 15)	20.0	24.1	(28 00)	238	30
SEA TEMP (DEG C)	17.0	(03 12)	20.9	24.3	(28 06)	238	30
AIR-SEA TEMP (DEG C)	-07.3	(14 18)	-00.6	04.1	(03 12)	238	30
PRESSURE (MBAR)	1006.2	(04 08)	1017.1	1028.1	(17 15)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 238

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		4.2	3.3	.4			7.9	11.8
NE	1.7	3.3	.4				5.4	5.2
E	2.1	2.1					4.2	3.8
SE	.8	6.7	.4				7.9	6.2
S	.4	7.1	15.1	2.5			25.6	13.8
SW	.4	4.6	10.0	1.3			16.3	13.3
W	1.3	7.6	13.6	.8			23.6	12.3
NW	.4	1.7	5.9	.4			8.4	13.7
CALM	.4						.4	.0
TOTAL	7.6	37.7	48.0	5.5			100.0	11.8

MAX WIND
SPEED: 26 KNOTS
DIRECTION: 180 DEG
DAY: 08
HOUR: 21

JUNE DATA SUMMARY 46001
AVERAGE LATITUDE 56.0N AVERAGE LONGITUDE 148.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	04.8	(02 08)	07.8	10.2	(05 21)	239	30
SEA TEMP (DEG C)	05.9	(01 15)	07.8	09.1	(30 06)	239	30
AIR-SEA TEMP (DEG C)	-01.7	(18 06)	-00.3	03.6	(05 21)	238	30
PRESSURE (MBAR)	1008.9	(09 15)	1020.6	1032.4	(09 00)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 239

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	2.9	2.1				5.4	10.2
NE	.8						.8	2.0
E								
SE	.8	1.7					2.5	6.0
S		7.5	8.8				16.3	11.5
SW	.8	7.5	22.6	5.0			36.0	15.6
W	.8	7.9	18.8	3.8			31.4	14.2
NW	.8	3.8	.8				5.4	7.7
CALM	1.3						1.3	.0
TOTAL	6.8	31.4	53.1	8.8			100.0	13.2

MAX WIND
SPEED: 26 KNOTS
DIRECTION: 270 DEG
DAY: 23
HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	6.3	56.1	31.8	5.4	.4				1.6M	4.0M	(18 18)

JUNE DATA SUMMARY 46002
AVERAGE LATITUDE 42.5N AVERAGE LONGITUDE 130.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.8	(03 12)	13.0	15.8	(08 03)	238	30
SEA TEMP (DEG C)	12.8	(01 15)	14.4	16.8	(08 00)	238	30
AIR-SEA TEMP (DEG C)	-03.6	(03 08)	-01.4	00.4	(05 18)	238	30
PRESSURE (MBAR)	1014.7	(02 12)	1022.2	1030.8	(15 21)	238	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 238

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	7.8	41.2	2.5			51.7	15.5
NE		.4	.4				.8	11.0
E								
SE								
S		1.3	.4				1.7	9.5
SW		1.3	10.1				11.3	13.7
W		3.8	11.3				15.1	13.2
NW		5.0	13.4				18.3	12.0
CALM								
TOTAL	.4	20.2	76.8	2.5			100.0	14.1

MAX WIND
SPEED: 23 KNOTS
DIRECTION: 340 DEG
DAY: 27
HOUR: 03

JUNE DATA SUMMARY 46003
AVERAGE LATITUDE 52.0N AVERAGE LONGITUDE 156.0W

MEANS AND EXTREMES

	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	03.9	(01 15)	06.4	08.3	(24 18)	239	30
SEA TEMP (DEG C)	04.9	(01 15)	06.2	07.1	(30 09)	238	30
AIR-SEA TEMP (DEG C)	-02.2	(11 12)	00.1	01.6	(24 18)	238	30
PRESSURE (MBAR)	1004.3	(10 06)	1021.2	1031.2	(22 09)	239	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 239

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.4	4.2	.8				5.4	7.8
NE	.4	.4	1.7				2.5	8.3
E			1.7				1.7	12.3
SE			.8				.8	15.0
S	.4	5.0	15.5	3.8			24.7	15.3
SW		6.3	21.8	9.2			37.2	16.7
W	.8	8.4	10.9				18.7	10.7
NW	.4	3.8	3.3				7.5	9.4
CALM	.4						.4	.0
TOTAL	2.9	28.0	56.1	13.0			100.0	13.8

MAX WIND
SPEED: 28 KNOTS
DIRECTION: 220 DEG
DAY: 17
HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 238

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	6.7	53.6	28.5	10.5	.8				1.7M	4.0M	(18 00)

MAY D A T A S U M M A R Y 46005

AVERAGE LATITUDE 46.0N AVERAGE LONGITUDE 131.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.8	(05 08)	09.7	11.6	(27 08)	240	31
SEA TEMP (DEG C)	08.8	(05 08)	10.5	11.8	(30 00)	240	31
AIR-SEA TEMP (DEG C)	-03.3	(05 08)	-00.8	00.8	(27 08)	240	31
PRESSURE (MBAR)	0993.5	(14 12)	1022.5	1039.7	(28 21)	240	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 240

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		6.8	14.2	2.8			23.8	13.7
NE		.8					.8	7.0
E	.4	.8	.4				1.7	7.3
SE		2.5					2.5	8.8
S		4.2	5.8	1.7			11.7	15.3
SW		4.6	7.9				12.5	13.7
W		2.9	13.8	2.1			18.8	14.0
NW		4.2	15.4	6.7			26.3	16.2
CALM								
TOTAL	.4	28.8	57.5	13.3			100.0	14.5

MAX WIND
SPEED: 27 KNOTS
DIRECTION: 310 DEG
DAY: 22
HOUR: 06

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 230

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	2.1	31.0	47.7	17.2	2.1				2.1M	4.5M	(01 00)

MAY D A T A S U M M A R Y 46006

AVERAGE LATITUDE 41.0N AVERAGE LONGITUDE 138.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.5	(14 03)	11.3	13.8	(08 03)	246	31
PRESSURE (MBAR)	1003.0	(14 03)	1027.8	1037.2	(22 21)	246	31

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 246

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.8	2.4	12.2				15.4	13.8
NE	.4	2.0	4.8				7.3	12.4
E	2.0	3.7	.8				6.5	6.5
SE	.8	3.7	2.0				6.5	8.6
S	2.0	4.9	6.5				13.4	8.6
SW	.8	4.1	8.3	1.2			15.4	13.8
W	.4	6.9	8.8	7.5			24.4	17.1
NW		1.2	6.9	2.0			10.2	17.0
CALM	.8						.8	.0
TOTAL	6.1	28.9	52.8	10.6			100.0	13.2

MAX WIND
SPEED: 32 KNOTS
DIRECTION: 310 DEG
DAY: 15
HOUR: 03

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 246

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	1.6	45.9	38.6	6.9	5.3	1.6			2.0M	6.0M	(15 06)

MAY D A T A S U M M A R Y 46007

AVERAGE LATITUDE 59.2N AVERAGE LONGITUDE 152.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	03.8	(05 06)	05.7	08.0	(21 06)	205	30
SEA TEMP (DEG C)	04.2	(17 03)	05.5	05.8	(24 12)	203	30
AIR-SEA TEMP (DEG C)	-02.0	(16 15)	00.2	02.2	(21 09)	203	30
PRESSURE (MBAR)	0984.6	(24 15)	1010.6	1027.2	(20 18)	204	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 201

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.0	1.5					2.5	3.5
NE	.5	4.5	7.5				12.4	10.8
E	1.0	14.4	17.9				33.3	11.3
SE	1.5	10.0	3.5				14.9	8.4
S	.5	10.9	1.0				12.4	7.4
SW	1.0	8.0	1.5				10.4	7.1
W	1.0	5.5	6.0				12.4	8.2
NW		1.5					1.5	6.7
CALM								
TOTAL	6.5	57.2	36.3				100.0	8.4

MAX WIND
SPEED: 21 KNOTS
DIRECTION: 110 DEG
DAY: 24
HOUR: 00

MAY D A T A S U M M A R Y 46008

AVERAGE LATITUDE 57.1N AVERAGE LONGITUDE 151.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	03.0	(09 18)	05.5	07.2	(20 03)	208	28
SEA TEMP (DEG C)	03.6	(06 15)	04.5	05.4	(01 00)	208	28
AIR-SEA TEMP (DEG C)	-01.0	(05 18)	01.0	02.4	(20 15)	208	28
PRESSURE (MBAR)	0981.4	(01 15)	1008.5	1028.4	(20 15)	208	28

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 207

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.9	4.8	.5				7.2	6.5
NE	1.0	7.7	1.9				10.6	8.1
E	.5	6.8	23.2	1.0			31.4	13.0
SE	1.4	4.8	8.7				15.0	11.8
S	.5	4.3	3.9				8.7	10.1
SW	1.0	5.8	7.7				14.5	10.4
W		2.9	6.3				9.2	11.1
NW	1.9	1.0	.5				3.4	4.4
CALM								
TOTAL	8.2	38.2	51.7	1.9			100.0	10.5

MAX WIND
SPEED: 29 KNOTS
DIRECTION: 080 DEG
DAY: 06
HOUR: 15

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 209

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	.5	42.8	27.3	20.0	8.3	1.0			3.2M	8.5M	(06 15)

MAY D A T A S U M M A R Y 46009

AVERAGE LATITUDE 60.2N AVERAGE LONGITUDE 146.8W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	04.4	(17 00)	06.6	11.3	(21 03)	192	28
SEA TEMP (DEG C)	06.6	(06 09)	07.0	08.9	(15 03)	191	28
AIR-SEA TEMP (DEG C)	-02.5	(17 18)	-00.4	03.9	(21 03)	191	28
PRESSURE (MBAR)	0988.0	(25 15)	1015.1	1028.8	(08 03)	191	28

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 188

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	2.6	4.8	1.6				9.0	5.8
NE	5.3	3.2	11.6	.5			20.6	11.2
E	2.1	14.3	25.9	2.1			44.4	11.6
SE	1.6	5.3	2.1				9.0	8.8
S	2.1	1.1					3.2	3.0
SW	1.1	2.1					3.2	5.2
W	1.6						1.6	1.3
NW	4.2	2.5	.5				7.4	4.4
CALM	1.6						1.6	.0
TOTAL	22.2	33.3	41.8	2.6			100.0	8.2

MAX WIND
SPEED: 26 KNOTS
DIRECTION: 070 DEG
DAY: 07
HOUR: 06

JUNE D A T A S U M M A R Y 46005

AVERAGE LATITUDE 46.0N AVERAGE LONGITUDE 131.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	09.1	(02 15)	11.9	14.8	(05 03)	215	30
SEA TEMP (DEG C)	11.2	(01 15)	12.4	13.8	(08 00)	214	30
AIR-SEA TEMP (DEG C)	-02.2	(03 15)	-00.6	01.7	(04 18)	214	30
PRESSURE (MBAR)	1011.1	(12 15)	1021.7	1028.8	(18 03)	215	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 215

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N		7.9	34.0	6.5			48.3	15.0
NE		4.2	1.4				5.6	8.8
E		1.4					1.4	7.4
SE								
S		2.8	3.3				6.0	12.0
SW		2.3	6.0				8.4	11.8
W		1.4	5.6	.5			7.9	15.0
NW		.9	20.5				21.4	15.7
CALM								
TOTAL		20.5	72.1	7.4			100.0	14.8

MAX WIND
SPEED: 27 KNOTS
DIRECTION: 350 DEG
DAY: 18
HOUR: 09

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 215

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	10.2	58.1	28.8	2.8					1.5M	3.0M	(20 21)

JUNE D A T A S U M M A R Y 46006

AVERAGE LATITUDE 41.0N AVERAGE LONGITUDE 138.0W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	10.0	(11 12)	12.7	14.8	(08 00)	232	30
SEA TEMP (DEG C)	13.7	(23 15)	14.1	14.4	(30 21)	64	8
AIR-SEA TEMP (DEG C)	-02.3	(28 18)	-01.8	-00.3	(29 00)	64	8
PRESSURE (MBAR)	1010.6	(06 12)	1028.8	1036.7	(14 21)	232	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 232

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.9	8.6	37.1				46.6	13.1
NE		2.6	3.0				5.6	11.9
E								
SE		.4	5.6	1.3			7.3	16.8
S		1.3	5.2	1.7			8.3	15.8
SW	.4	.9	5.2	.4			6.9	14.7
W	.9		11.6	1.3			13.8	17.3
NW	.4	3.4	6.5				10.3	13.8
CALM	1.3						1.3	.0
TOTAL	3.9	17.2	74.1	4.7			100.0	14.8

MAX WIND
SPEED: 30 KNOTS
DIRECTION: 180 DEG
DAY: 08
HOUR: 08

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 230

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	.8	70.8	25.4	3.1					1.9M	3.5M	(08 15)

JUNE D A T A S U M M A R Y 46007

AVERAGE LATITUDE 59.2N AVERAGE LONGITUDE 152.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	05.5	(01 09)	07.7	11.0	(20 03)	182	22
SEA TEMP (DEG C)	06.4	(07 12)	07.0	08.7	(21 21)	181	22
AIR-SEA TEMP (DEG C)	-01.1	(04 00)	00.7	03.5	(08 03)	180	22
PRESSURE (MBAR)	1007.8	(14 18)	1017.1	1026.2	(06 03)	182	22

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 180

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	.5	1.3					1.8	4.1
NE	.6						.6	5.0
E	1.3	5.0	2.5	.6			9.4	8.9
SE	1.3	15.0	10.0				26.9	8.9
S	3.1	20.6	13.8				37.5	8.3
SW	1.3	6.3	1.3				8.8	6.8
W	.6	7.5	4.4				12.5	9.3
NW	1.8						1.8	2.7
CALM	.6						.6	.0
TOTAL	11.3	55.6	32.5	.6			100.0	8.9

MAX WIND
SPEED: 22 KNOTS
DIRECTION: 110 DEG
DAY: 14
HOUR: 18

JUNE D A T A S U M M A R Y 46008

AVERAGE LATITUDE 57.1N AVERAGE LONGITUDE 151.7W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	05.7	(01 12)	07.5	08.8	(12 08)	189	21
SEA TEMP (DEG C)	04.7	(01 12)	06.0	07.8	(04 00)	189	21
AIR-SEA TEMP (DEG C)	00.1	(16 06)	01.6	03.9	(12 06)	189	21
PRESSURE (MBAR)	1008.3	(09 15)	1018.8	1028.2	(05 03)	189	21

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 189

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	1.3	4.8					6.1	4.1
NE	2.4	4.8					7.3	4.3
E	1.2	3.6					4.8	5.9
SE	2.4						2.4	1.8
S	1.8	7.9	4.8				14.5	8.8
SW	2.4	27.9	23.6				53.9	10.5
W		7.8	2.4				10.3	8.1
NW	.6						.6	3.0
CALM								
TOTAL	12.1	57.0	30.9				100.0	8.7

MAX WIND
SPEED: 19 KNOTS
DIRECTION: 330 DEG
DAY: 17
HOUR: 18

WAVES - % FREQUENCIES, MEAN AND EXTREME (METERS) — NO. OF WAVE OBS: 193

HEIGHT (M)	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	MEAN	MAX	(DA HR)
% FREQUENCY	15.7	57.5	18.8	7.3	.7				1.4M	4.0M	(17 15)

JUNE D A T A S U M M A R Y 46009

AVERAGE LATITUDE 60.2N AVERAGE LONGITUDE 146.8W

MEANS AND EXTREMES	MIN	(DA HR)	MEAN	MAX	(DA HR)	NO. OF OBS	DAYS WITH DATA
AIR TEMP (DEG C)	08.1	(02 18)	09.1	13.4	(21 06)	212	30
SEA TEMP (DEG C)	07.4	(04 00)	09.8	12.8	(30 03)	211	30
AIR-SEA TEMP (DEG C)	-03.4	(18 18)	-00.8	02.5	(21 06)	210	30
PRESSURE (MBAR)	1007.3	(26 09)	1019.1	1028.6	(09 15)	211	30

WIND - % FREQUENCIES, MEANS AND EXTREMES — NO. OF OBS: 210

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL %	MEAN SPEED (KNOTS)
N	4.3	7.6					11.9	4.0
NE	3.8	1.9	.5				6.2	3.5
E	2.4	13.3	7.6				23.3	6.5
SE	5.2	18.4	2.4				26.0	5.8
S	5.7	15.2	.5				21.4	5.5
SW	7.6	3.3					11.0	3.8
W	1.9						1.9	1.5
NW	1.4	2.4					3.8	3.5
CALM	1.4						1.4	.0
TOTAL	33.8	55.2	11.0				100.0	5.4

MAX WIND
SPEED: 18 KNOTS
DIRECTION: 070 DEG
DAY: 26
HOUR: 00

Table 9
Selected Gale and Wave Observations, North Atlantic
May and June 1978

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10°	Wind: Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C: Air	Temperature °C: Sea	Sea Waves+: Period sec.	Sea Waves+: Height ft.	Swell Waves: Dir. 10°	Swell Waves: Period sec.	Swell Waves: Height ft.
NORTH ATLANTIC OCEAN		MAY															
SEALAND RESOURCE	AMERICAN	1	48.0 N	48.1 W	00	29	40	5 NM	00	1004.0	8.0	14.5					
LIGHTNING	AMERICAN	2	42.9 N	33.0 W	00	29	35	10 NM	02	1013.3	13.3	14.4	2	8	28	< 6	11.5
ALMERIA LYKES	AMERICAN	3	43.8 N	22.7 W	12	34	36	10 NM	01	1012.9	12.2	12.2	3	8			
KEYSTONER	AMERICAN	3	19.4 N	84.8 W	06	14	35	10 NM	02	1006.4	27.8	27.2			14	< 6	10
SEALIFT PACIFIC	AMERICAN	4	38.8 N	14.8 W	06	32	35	10 NM	15	1012.1	14.6	14.3	2	6.5	32	< 6	11.5
AMER ACE	AMERICAN	6	46.0 N	37.3 W	06	27	40	5 NM	02	998.0	11.2	13.4	5	24.5			
EXPORT LEADER	AMERICAN	6	48.1 N	30.8 W	18	26	35	5 NM	02	993.2	12.2	13.4	6	21			
HOEGH MALLARD	NORWEGIAN	6	44.7 N	26.9 W	18	25	M 38	10 NM	80	1009.1	14.8	13.0	10	14.8			
AMER LEADER	AMERICAN	7	47.0 N	23.4 W	11	18	28	2 NM	64	995.9	12.7	12.2	9	23	25	8	29.5
HOEGH MALLARD	NORWEGIAN	7	43.6 N	28.7 W	06	21	M 42	10 NM	80	1004.5	14.8		6	10	27	10	13
ZIM HONGKONG	ISRAEL	8	40.6 N	40.2 W	18	23	40	5 NM	01	1005.5	16.0		5	6.5	28	7	11.5
SEALAND MARKET	AMERICAN	8	40.2 N	44.0 W	18	32	40	10 NM	25	1006.0	13.4	14.5	5	8	32	10	16.5
DAVID D IRWIN	AMERICAN	9	40.6 N	72.2 W	12	18	50	.5 NM	64	1010.5	16.0	5.5	4	10	09	6	10
DOCTOR LYKES	AMERICAN	9	28.7 N	75.3 W	06	17	M 35	5 NM	03	1018.0	22.7	20.0					
AUSTRAL PATRIOT	AMERICAN	10	39.3 N	67.0 W	00	19	40	2 NM	02	1015.9	18.9	16.2	6	11.5			
EXPORT PATRIOT	AMERICAN	10	39.3 N	63.8 W	06	21	35	5 NM	02	1018.6	16.7	22.3	3	10	20	6	11.5
STATE OF MAINE	AMERICAN	10	36.4 N	71.0 W	06	17	37	2 NM	18	1010.8	24.5	19.6	5	18			
AMER LEADER	AMERICAN	11	41.8 N	60.9 W	06	20	35	2 NM	62	1012.0	14.5	12.2	4	8	22	12	13
ADM W M CALLAGHAN	AMERICAN	11	57.2 N	17.4 W	18	26	36	8 NM	50	1023.0	11.2	7.8	4	6.5	27	9	18
ADM W M CALLAGHAN	AMERICAN	12	56.6 N	20.1 W	00	29	40	5 NM	25	1028.0	11.1	8.3			29	9	16.5
TEXACO MISSISSIPPI	AMERICAN	16	38.2 N	68.8 W	18	16	40	10 NM	15	1010.5	26.2	22.8	6	8			
TEXACO MISSISSIPPI	AMERICAN	17	36.8 N	70.2 W	06	16	35	10 NM	13	1012.5	23.0	24.4	4	5			
UNIVERSE	LIBERIAN	30	40.0 N	33.7 W	00	23	35	2 NM	60	1008.5	18.0	17.3	5	10	14	< 6	10
GREAT LAKES VESSELS																	
ERNEST R BREECH	AMERICAN	1	45.2 N	83.1 W	18	29	36	> 25 NM	02		3.0	2.0	2	5			
CHARLES M WHITE	AMERICAN	8	41.9 N	80.7 W	00	07	M 35	10 NM	03		2.0	1.0	5	8			
JOHN DYKSTRA	AMERICAN	11	46.7 N	84.9 W	18	20	M 45	10 NM	02		12.0	2.0	8	8			
GEORGE A SLOAN	AMERICAN	13	44.7 N	86.3 W	18	02	M 35	5 NM	21		4.0	2.0	4	11.5			
JOHN G MUNSON	AMERICAN	14	41.6 N	87.3 W	00	35	M 45	2 NM	21		4.0	10.0		10			
JOSEPH M THOMPSON	AMERICAN	14	47.8 N	88.6 W	06	04	M 35	8 NM	21		5.0	1.0	8	6.5			
THOMAS WILSON	AMERICAN	14	48.1 N	86.2 W	06	06	M 46	8 NM	21		4.0	4.0	3	6.5			
NORTH ATLANTIC OCEAN		MAY															
ENVIRONMENTAL BUOYS																	
44004	AMERICAN	9	39.0 N	70.0 W	21	18	M 36			1013.0	17.0	17.8					
44004	AMERICAN	10	39.0 N	70.0 W	00	18	M 37			1011.0	18.0	17.7					
NORTH ATLANTIC OCEAN		JUNE															
METEORIT-AKR9)	AMERICAN	1	48.5 N	37.1 W	00	36	40	5 NM	01	1006.0	11.1	10.1	2	8	36	6	18
MAYAGUEZ	AMERICAN	4	32.4 N	73.0 W	18	21	40	2 NM	16	1008.8	24.5	25.0	4	5	21	7	8
SEALAND GALLOWAY	AMERICAN	5	42.9 N	41.1 W	18	19	35	10 NM	03	1023.4	17.3	14.4	6	8			
SEALAND GALLOWAY	AMERICAN	6	42.8 N	47.2 W	06	18	35	5 NM	15	1008.8	14.0	9.5	6	10	18	10	10
BRIDGE	BRITISH	10	22.0 N	20.0 W	18	03	35	10 NM	05	1016.1	20.6	22.7	5	6.5			
DYVI KATTEGAT	NORWEGIAN	14	40.8 N	61.5 W	13	18	M 36	5 NM	03	1011.3	21.0						
BRIDGE	BRITISH	14	40.8 N	13.1 W	18	33	36	5 NM	05	1018.3	16.7	18.3			34	7	8
DYVI KATTEGAT	NORWEGIAN	18	41.7 N	54.0 W	11	18	M 40	5 NM	91	1019.8	20.0						
DALAMAN	TURKISH	20	37.9 N	65.4 W	06	21	35	2 NM	50	1019.0	20.0	20.0					
SEALAND PIONEER	AMERICAN	20	17.0 N	75.8 W	12	05	M 35	5 NM	03	1015.9	28.0	28.0	5	6.5	09	< 6	6.5
MOBIL ENGINEER	LIBERIAN	23	12.6 N	74.5 W	18	07	M 42	10 NM	03	1014.0	29.0	28.0	8	13			
TRANSCOLORADO	AMERICAN	27	43.7 N	46.9 W	18	23	40	2 NM		1014.8	15.6	19.4	10	10	23	13	16.5
GREAT LAKES VESSELS																	
G M HUMPHREY	AMERICAN	2	47.5 N	87.8 W	06	27	M 37	10 NM	03		6.0	6.0	5	3			
G M HUMPHREY	AMERICAN	8	46.9 N	85.6 W	00	02	M 37	10 NM	18		1.0	7.0	4	8			
CHARLES M WHITE	AMERICAN	10	46.8 N	85.1 W	06	23	M 35	> 25 NM	01		13.0	6.0	6	5			
GEORGE A SLOAN	AMERICAN	11	44.6 N	86.4 W	00	19	M 37	> 25 NM	00		16.0	5.0		6.5			

+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds $\geq$ 35 kn or waves $\geq$ 25 ft from May through August ($\geq$ 41 kn or $\geq$ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Table 10

Selected Gale and Wave Observations, North Pacific

May and June 1978

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10°	Wind: Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C: Air	Temperature °C: Sea	Sea Waves*: Period sec.	Sea Waves*: Height ft.	Swell Waves: Dir. 10°	Swell Waves: Period sec.	Swell Waves: Height ft.
NORTH PACIFIC OCEAN		MAY															
TRANSCHAMPLAIN	AMERICAN	1	37.6 N	125.1 W	06	33	35	10 NM	02	1017.4	12.2	14.4	4	10	33	10	13
CHERISH	JAPANESE	1	53.4 N	139.9 W	18	23	M 52	.25 NM	65	983.3	6.0	7.0			25	10	23
ANNA MAERSK	DANISH	1	50.2 N	141.1 W	18	23	35	5 NM	80	1001.5	7.0	9.0			26	7	18
PRINCE WILLIAM SOUND	AMERICAN	1	56.9 N	140.3 W	18	10	40	2 NM	50	980.4	6.1	7.2	3	11.5			
NORBU	LIBERIAN	1	51.5 N	132.8 W	18	21	35	10 NM	20	1005.5	10.0	6.0	4	10	24	10	16.5
ARCO JUNEAU	AMERICAN	2	55.7 N	137.3 W	12	18	35	10 NM	15	1000.5	6.6	3.9	3	10	24	8	24.5
CHERISH	JAPANESE	2	53.4 N	141.0 W	00	26	M 40	.5 NM	20	997.8	4.0	5.0					
PORTLAND	AMERICAN	2	53.7 N	137.4 W	00	24	45	2 NM	05	996.8	7.8	6.7	4	6.5	24	7	23
NORTH STAR III	AMERICAN	2	53.4 N	167.8 W	12	32	M 40	2 NM	62	1006.1	2.2	5.0	3	6.5			
SANSINENA II	AMERICAN	2	54.9 N	142.2 W	00	27	36	2 NM	51	986.0	6.7	4.4	5	8	27	9	16.5
PRINCE WILLIAM SOUND	AMERICAN	2	55.3 N	137.5 W	06	25	45	2 NM	01	999.7	7.3	7.7	5	11.5	26	< 6	14.5
PHILADELPHIA	AMERICAN	2	55.4 N	140.9 W	06	25	45	5 NM	02	995.9	5.0	5.6	6	19.5	25	6	41
SEALAND EXCHANGE	AMERICAN	2	42.6 N	154.7 E	18	09	40	2 NM	02	999.7	11.1	8.9	3	16.5			
NORBU	LIBERIAN	2	52.1 N	134.0 W	00	23	45	10 NM	01	1009.0	9.0	6.0	6	13	23	12	26
GREAT LAND	AMERICAN	2	56.3 N	141.7 W	06	25	M 42	2 NM	50	989.8	5.0	6.2					
FAIRWEATHER	AMERICAN	3	39.6 N	124.5 W	00	33	M 41	10 NM	03	1019.0	12.3	11.2			32	< 6	11.5
SEALAND EXCHANGE	AMERICAN	3	44.0 N	158.3 E	00	16	35	1 NM	53	1003.7	7.8	6.7	3	16.5			
ROSE	LIBERIAN	3	37.1 N	164.5 W	18	04	36	10 NM	06	1019.6	10.4	15.0					
HAWAIIAN QUEEN	AMERICAN	3	37.1 N	125.8 W	12	22	M 40	10 NM	02	1018.0	11.7	13.3	4	13			
MASON LYKES	AMERICAN	3	38.8 N	136.6 W	18	02	40	5 NM	62	1015.9	10.6	12.2	5	6.5	02	7	10
VERRAZANO BRIDGE	JAPANESE	3	37.0 N	163.0 W	18	03	M 37	5 NM	02	1018.0	11.0	13.0	8	26	06	12	16.5
CHEVRON MISSISSIPPI	AMERICAN	3	38.4 N	124.0 W	18	34	35	10 NM	02	1019.8	12.2	8.8	4	6.5	34	6	11.5
ROSE	LIBERIAN	4	37.4 N	163.1 W	00	03	M 37	5 NM	03	1016.5	10.7	14.5					
PRES POLK	AMERICAN	4	37.4 N	160.0 W	06	04	35	.5 NM	45	1009.8	10.6	12.8	5	10	04	6	19.5
MOBIL ARCTIC	AMERICAN	4	38.2 N	123.8 W	18	34	45	5 NM	02	1015.0	12.0	9.0	7	8	33	>13	16.5
HAWAIIAN	AMERICAN	4	37.3 N	124.4 W	18	34	38	5 NM	03	1017.9	12.8	14.5	8	18			
JAPAN ACE	JAPANESE	4	42.5 N	155.5 W	12	04	M 38	2 NM	63	1012.5	8.0	9.5	5	10	07	6	11.5
OVERSEAS JUNEAU	AMERICAN	4	38.5 N	124.6 W	18	34	40	5 NM	02	1018.6	14.0	10.0			32	< 6	13
CHEVRON MISSISSIPPI	AMERICAN	4	39.4 N	124.9 W	00	34	38	10 NM	02	1020.8	12.8	11.1	5	8	34	8	14.5
OVERSEAS JUNEAU	AMERICAN	5	39.5 N	125.6 W	00	36	35	5 NM	01	1020.7	11.2	11.7	3	8	36	6	11.5
NANCY LYKES	AMERICAN	5	34.7 N	123.2 W	12	36	50	5 NM	05	1022.0	12.3	12.3	6	23	36	7	32.5
HAWAIIAN QUEEN	AMERICAN	5	37.0 N	125.3 W	18	34	M 50	10 NM	01	1021.0	12.2	13.3	7	14.5			
MOBIL ARCTIC	AMERICAN	5	41.0 N	126.0 W	12	34	40	10 NM	02	1016.9	12.0	11.0	5	8	34	7	13
PRES POLK	AMERICAN	5	37.4 N	169.2 W	06	34	35	10 NM	25	1022.0	8.9	12.8	6	10	32	6	16.5
PRINCE WILLIAM SOUND	AMERICAN	5	40.3 N	124.9 W	00	02	38	10 NM	02	1022.4	15.5	12.3	5	11.5			
PRES MONROE	AMERICAN	5	42.5 N	157.5 W	18	30	50	2 NM	07	989.8	5.0	6.1	6	14.5	34	7	24.5
TRADEWIND EAST	PANAMANIAN	5	49.8 N	156.2 W	18	06	40	2 NM	80	1000.4	4.0	8.0	8	11.5	05	>13	13
VIOLET	LIBERIAN	5	38.8 N	160.5 W	06	02	M 38	2 NM	81	1005.0	7.0	12.0	4	8	32	13	13
GREAT LAND	AMERICAN	6	57.6 N	143.7 W	18	09	M 40	2 NM	50		6.2	5.6					
JAPAN CADBO	LIBERIAN	6	34.4 N	121.0 W	00	33	40	5 NM	07	1007.5	13.5	12.0	4	14.5	30	9	24.5
NANCY LYKES	AMERICAN	6	35.7 N	124.8 W	06	36	50	> 25 NM	00	1025.0	12.7	14.5	6	24.5	36	7	34.5
NEVADA	AMERICAN	6	37.3 N	125.3 W	00	05	41	5 NM	02	1017.0	15.0	9.5	5	6.5	05	7	14.5
PRES VAN BUREN	AMERICAN	6	38.7 N	124.9 W	06	36	40	10 NM	02	1019.0	11.7	11.1	5	13	36	8	16.5
PRES MONROE	AMERICAN	6	42.2 N	152.3 W	06	24	45	5 NM	62	1004.4	7.2	7.8	6	19.5	24	7	29.5
PACDUKE	LIBERIAN	6	54.0 N	150.6 W	00	08	M 35	2 NM	51	1012.0	5.0	9.0	6	10			
PORTLAND	AMERICAN	6	56.9 N	150.9 W	18	09	47	.25 NM	47	1002.5	6.7	5.6	4	8	09	6	13
TRADEWIND EAST	PANAMANIAN	6	49.7 N	152.2 W	12	12	40	1 NM	60	979.4	5.0	8.0	8	11.5	12	13	11.5
AMERICA MARU	JAPANESE	6	47.7 N	156.8 W	18	28	M 42	2 NM	02	991.5	5.0	10.0	5	6.5	28	>13	19.5
DISCOVERER	AMERICAN	6	59.3 N	153.7 W	21	05	M 45	2 NM	63	1012.6	4.0	4.4	4	6.5			
SHUNWIND	LIBERIAN	6	53.6 N	156.5 W	06	03	M 50	2 NM	07	999.0	3.0	6.0	8	29.5	05	10	29.5
SEALAND EXCHANGE	AMERICAN	6	52.7 N	145.8 W	00	11	45	2 NM	65	1010.0	5.0	4.4	4	11.5			
PRES POLK	AMERICAN	7	37.2 N	170.7 E	12	26	41	10 NM	25	1002.0	10.0	12.2	7	19.5			
NANCY LYKES	AMERICAN	7	37.7 N	127.0 W	00	36	35	10 NM	00	1027.4	16.5	13.3	4	10			
GREAT LAND	AMERICAN	7	58.5 N	149.2 W	00	08	M 38	.5 NM	52	1008.5	6.8	6.1	8	11.5			
JAPAN CADBO	LIBERIAN	7	33.2 N	125.2 W	00	34	38	5 NM	02	1017.5	15.0	16.0	6	14.5			
AMER CHIEFTAIN	AMERICAN	7	36.2 N	169.4 W	18	23	40	5 NM	50	1003.7	15.6	13.4	6	19.5	21	9	29.5
ALBERT MAERSK	DANISH	7	38.2 N	168.5 E	06	30	35	10 NM	02	1001.5	11.2		7	14.5			
DISCOVERER	AMERICAN	7	59.3 N	153.1 W	00	04	M 40	2 NM	63	1010.4	4.5	4.9	7	10			
ARCO FAIRBANKS	AMERICAN	7	59.6 N	145.0 W	12	10	M 36	5 NM	07	1012.0	11.0	5.5	6	23			
ARIZONA	AMERICAN	7	40.6 N	153.9 E	06	21	40	10 NM	02	1011.2	10.0	5.6	5	13	21	8	19.5
SHUNWIND	LIBERIAN	7	52.9 N	162.0 W	00	34	M 40	5 NM	07	1000.0	5.0	7.0	8	19.5	34	8	29.5
VIOLET	LIBERIAN	8	37.4 N	178.7 E	00	27	M 40	10 NM	01	1005.0	11.0	14.0	9	10	28	11	13
PRES POLK	AMERICAN	8	36.9 N	168.6 E	00	30	35	10 NM	01	1010.0	11.1	11.1	7	14.5	31	12	19.5
GOLDEN MARINER	PANAMANIAN	8	48.2 N	172.8 W	06	04	M 38	2 NM		990.0	4.0	4.0	5	6.5			
NORTH STAR III	AMERICAN	8	53.2 N	167.9 W	12	05	M 46	10 NM	03	1002.4	2.8	6.1	8	8			
LING YUNG	CHINESE	9	52.4 N	144.5 W	18	16	35	2 NM	51	1002.5	8.5	7.0	5	10	24	8	19.5
TRIUMPH	PANAMANIAN	10	52.0 N	167.4 W	12	32	M 35	10 NM	02	1008.4	3.0	7.5	4	11.5	33	7	13
DOLLY TURMAN	AMERICAN	10	35.7 N	148.0 E	12	14	M 35	5 NM	02	1015.0	18.3	16.7	XX	10	13		16.5
PRES POLK	AMERICAN	10	34.6 N	151.0 E	00	16	35	10 NM	02	1023.5	17.8	13.6	6	10	16	12	16.5
PHILADELPHIA	AMERICAN	10	37.0 N	143.9 W	06	11	35	2 NM	20	1002.4	7.2	4.4	4	14.5	23	9	23
LING YUNG	CHINESE	10	53.3 N	149.7 W	06	18	35	2 NM	51	991.0	6.0	5.5	5	11.5	25	8	19.5
VAN CONQUEROR	LIBERIAN	11	52.3 N	163.6 W	00	31	M 40	5 NM	01	1009.0	4.0	7.0					
WORLD RUBY	LIBERIAN	11	40.8 N	164.8 E	18	24	45	2 NM	02	1008.0	6.5	4.0			24	>13	29.5
ASIA BEAUTY	LIBERIAN	11	52.1 N	174.4 E	00	21	M 37	1 NM	59	1009.5	7.2	2.0	6	23	25	6	23
ALEUTIAN DEVELOPER	AMERICAN	11	54.0 N	164.9 W	00	31	35	5 NM	02	1006.4	3.9	2.8	4	8	31	6	14.5
TRIUMPH	PANAMANIAN	11	51.3 N	176.0 W	18	23	M 36	1 NM	25	1008.7	4.5	9.5	4	13	27	9	14.5
SEALAND FINANCE	AMERICAN	11	51.8 N	173.0 E	12	25	35	2 NM	50	1007.5	3.9	3.3	5	8			
PRES VAN BUREN	AMERICAN	11	53.1 N	180.0 W	12	25	35	5 NM	50	1006.5	4.4	2.8	3	8	25	6	10
VAN WARRIOR	LIBERIAN	12	40.0 N	163.0 W	18	27	40	1 NM	59	1009.0	9.0	8.0					
VAN CONQUEROR	LIBERIAN	12	51.2 N	175.2 W	12	25	M 35	2 NM	60	1003.0	5.0	8.0					
ALEUTIAN DEVELOPER	AMERICAN	12	51.9 N	173.0 W	00	25	44	2 NM	65	999.7	6.1	3.9	4	10	25	7	23
SEALAND FINANCE	AMERICAN	12	49.9 N	166.6 E	00	23	35	10 NM	02	1007.5	4.4	3.3	6	10			
TRIUMPH	PANAMANIAN	12	51.1 N	177.2 W	00	24	M 38	1 NM	10	998.0	5.0	8.0	6	19.5	22	13	24.5
PRES VAN BUREN	AMERICAN	12	51.5 N	172.1 E	06	26	35	10 NM	02	1007.2	4.4	2.8	4	8	24	12	11.5
QUEENS WAY BRIDGE	JAPANESE	12	46.6 N	169.8 W	12	26	M 41	5 NM	25	1012.3	7.5	5.0					
PRES PIERCE	AMERICAN	12	51.8 N	173.7 E	18	29	40	10 NM	02	1012.5	5.0	3.8	4	6.5	27	6	13
LING YUNG	CHINESE	12	53.4 N	175.1 W	12	26	35	2 NM	51	997.0	5.0	4.0	7	19.5			
MAMMOTH FIR	LIBERIAN	12	51.7 N	171.8 W	00	24	M 40	2 NM	21	1004.0	6.0	8.0	9	19.5	24	9	29.5
VAN WARRIOR	LIBERIAN	13	47.0 N	154.5 W	18	31	45	2 NM	62	1006.8	8.0	7.0					

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10°	Wind: Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C: Air	Temperature °C: Sea	Sea Waves*: Period sec.	Sea Waves*: Height ft.	Swell Waves: Dir. 10°	Swell Waves: Period sec.	Swell Waves: Height ft.
NORTH PACIFIC OCEAN		MAY															
GRAND CARRIER	LIBERIAN	13	52.7 N	169.0 W	06	27	M 40	5 NM	03	1006.0	5.0	5.0					
DAIKI MARU	JAPANESE	13	43.2 N	155.5 W	12	30	M 44	1 NM	25	1006.5	5.5	8.0			29	9	18
JAPAN ACE	JAPANESE	13	43.1 N	142.0 W	18	23	M 42	2 NM	62	995.5	8.5	11.5	5	11.5	28	8	19.5
VAN ENTERPRISE	LIBERIAN	14	45.2 N	143.5 W	19	29	M 37	5 NM	02	1008.0	8.5	7.0			30	7	29.5
ALSTER EXPRESS	GERMAN	14	39.2 N	137.9 W	00	27	37	5 NM	80	1007.5	12.4	13.6		6.5	28		11.5
VAN WARRIOR	LIBERIAN	14	46.7 N	152.6 W	00	32	35	10 NM	01	1009.0	13.5	6.0					
VENEZUELA MARU	JAPANESE	14	42.6 N	137.0 W	12	28	M 36	5 NM	15	997.5	9.0	13.5	6	10	26	10	16.5
JAPAN ACE	JAPANESE	14	43.2 N	142.7 W	00	28	M 42	5 NM	25	996.0	10.0	10.0	6	13	27	9	49
ARCTIC TOKYO	LIBERIAN	15	48.6 N	158.3 E	00	25	M 35	5 NM	05	1023.0	4.0	3.0					
BEISHU MARU	JAPANESE	15	53.4 N	152.6 W	18	21	M 35	2 NM	81	992.0	4.5	3.5	3	5	22	8	10
VENEZUELA MARU	JAPANESE	15	43.5 N	139.2 W	00	31	M 40	5 NM	01	1007.6	11.0	13.0	6	10	28	10	19.5
TOKYO RAINBOW	JAPANESE	15	48.9 N	170.9 E	12	25	M 40	5 NM	02	1014.5	4.8	4.0			25	6	8
GRAND CARRIER	LIBERIAN	15	48.7 N	169.5 E	18	27	M 40	1 NM	10	1016.5	4.0	3.0					
JAPAN ACE	JAPANESE	15	42.3 N	147.5 W	00	29	M 17	5 NM	02	1021.2	10.0	10.0	6	10	31	8	24.5
ORIENTAL STATESMAN	LIBERIAN	15	37.9 N	134.8 W	06	34	M 42	5 NM	03	1015.9	13.8	14.0	5	13	25	6	14.5
OCEAN DUKE	KOREAN	15	54.2 N	156.3 W	00	12	40	2 NM	60	997.0	3.5	8.0	6	13			
ORIENTAL SOVERIGN	LIBERIAN	15	51.1 N	156.4 W	18	25	M 36	5 NM	01	996.0	6.5	5.0	10	19.5			
PRES TRUMAN	AMERICAN	16	53.7 N	154.5 W	06	21	38	5 NM	60	993.9	4.4	4.4	4	8	23	9	13
ORIENTAL SOVERIGN	LIBERIAN	16	51.1 N	157.5 W	00	26	M 36	5 NM	03	998.0	8.0	5.0	10	16.5	26	12	24.5
DAIKI MARU	JAPANESE	16	44.8 N	170.8 W	09	27	38	2 NM	60	1014.0	7.5	7.5	6	6.5	26	7	13
TOKYO RAINBOW	JAPANESE	16	48.2 N	169.4 E	00	27	M 36	2 NM		1019.0	3.7	3.0			27	6	10
PRESIDENT MADISON	AMERICAN	17	50.0 N	152.0 W	00	19	M 35	5 NM	25	1009.0	5.6	5.0	4	8	25	8	13
HAWAIIAN QUEEN	AMERICAN	17	36.3 N	128.0 W	12	02	M 40	10 NM	01	1023.0	12.8	14.4	2	5			
PRESIDENT MADISON	AMERICAN	18	50.0 N	139.7 W	00	18	M 35	5 NM	02	1023.5	3.3	8.3	4	8	24	8	11.5
DAIKI MARU	JAPANESE	18	44.5 N	176.2 E	18	27	M 38	1 NM	63	995.5	5.5	5.5	6	10			
ALASKA STANDARD	AMERICAN	18	39.2 N	139.2 W	18	13	35	5 NM	61	1020.0	6.7	11.2	4	6.5			
AMERICAN INDEPENDENCE	AMERICAN	18	39.5 N	125.9 W	12	35	M 48	5 NM	02	1015.2	11.1	14.0	7	29.5			
DAIKI MARU	JAPANESE	19	44.7 N	174.3 E	06	33	M 43	.5 NM		1010.0	5.5	6.5	6	10	33	9	18
AMERICAN INDEPENDENCE	AMERICAN	19	41.2 N	127.4 W	00	35	M 38	5 NM	02	1018.3	13.4	14.0	7	36			
VIOLET	LIBERIAN	19	38.1 N	165.0 E	06	14	M 36	2 NM	51	1003.0	17.0	11.0	6	8	20	7	10
TAIWAN PHOENIX	SINGAPORE	19	42.0 N	165.0 E	12	09	M 35	2 NM	63	1000.0	10.0	7.0	7	13			
NORTH STAR III	AMERICAN	20	53.9 N	166.5 W	18	12	M 35	1 NM	10	1021.3	5.8	5.6	5	8			
PRES JEFFERSON	AMERICAN	20	34.5 N	174.2 W	06	09	35	5 NM	50	1019.0	4.5	4.0	5	10			
VIOLET	LIBERIAN	20	42.9 N	152.7 E	06	13	M 35	2 NM	51	1003.0	10.0	6.0	6	10	21	8	13
TAIWAN PHOENIX	SINGAPORE	20	42.8 N	148.9 E	00	09	M 36	2 NM	65	999.2	9.7	7.0	6	16.5			
PRES CLEVELAND	AMERICAN	21	49.6 N	128.0 W	06	31	35	10 NM	02	1016.9	9.5	11.1	6	5	31	6	10
ROSE CITY	AMERICAN	21	47.8 N	127.0 W	06	32	37	10 NM	01	1016.1	10.0	6.6	XX	6.5	30	6	11.5
VAN ENTERPRISE	LIBERIAN	21	45.0 N	170.1 E	18	18	M 40	2 NM	51	995.0	7.0	3.0	10	14.5			
CORNUCOPIA	AMERICAN	22	42.4 N	128.4 W	00	36	M 40	10 NM	02	1024.5	12.2	13.4	6	10			
GALVESTON	AMERICAN	22	53.5 N	135.3 W	18	31	35	5 NM	01	1018.8	9.5	8.4	4	8	30	8	11.5
MANHATTAN	AMERICAN	22	38.1 N	123.8 W	18	33	35	5 NM	00	1015.6	12.8	12.8	9	10			
PRES CLEVELAND	AMERICAN	22	52.1 N	137.4 W	06	31	35	10 NM	02	1023.7	7.7	8.4	6	6.5	31	< 6	11.5
PIONEER CONTENDER	AMERICAN	22	36.6 N	125.8 W	18	35	40	10 NM	03	1021.5	13.3	12.2	5	10	34	6	16.5
ROSE	LIBERIAN	22	36.1 N	127.3 W	06	36	M 35	10 NM	02	1022.3	13.0	16.0					
PRESIDENT MADISON	AMERICAN	22	52.0 N	137.6 W	18	32	M 40	5 NM	50	1024.0	7.8	9.4	5	13	31	8	14.5
SOUTH GLORY	LIBERIAN	22	40.5 N	170.5 E	00	21	35	.5 NM	40	1000.7	9.0	10.0	2	5	23	< 6	8
ARCO FAIRBANKS	AMERICAN	22	52.2 N	136.0 W	18	32	M 36	5 NM	02	1019.8	6.7	8.4	3	6.5	31	< 6	11.5
SANTA CLARA	AMERICAN	22	40.2 N	125.1 W	00	35	35	10 NM	02	1018.6	12.2	12.8			35	8	14.5
SEALAND COMMERCE	AMERICAN	22	47.0 N	138.4 W	00	31	35	10 NM	02	1031.0	10.0	10.0	8	8			
HONGKONG SUCCESS	LIBERIAN	23	45.0 N	129.3 W	18	32	41	5 NM	25	1018.0	13.0	14.0	6	13	32	6	16.5
MANHATTAN	AMERICAN	23	38.7 N	124.2 W	00	33	40	5 NM	02	1017.0	12.7	12.8	9	16.5			
PRES CLEVELAND	AMERICAN	23	54.2 N	155.2 W	18	18	35	5 NM	02	1003.7	6.1	5.5	4	5	19	6	10
PRESIDENT MADISON	AMERICAN	23	52.5 N	140.8 W	00	32	M 35	5 NM	02	1027.0	5.6	9.4	5	13	31	8	14.5
PRINCE WILLIAM SOUND	AMERICAN	23	40.1 N	124.9 W	12	35	M 35	10 NM	02	1015.7	10.2	10.4	3	8	32	< 6	10
CORNUCOPIA	AMERICAN	23	46.9 N	133.9 W	00	32	M 35	5 NM	02	1025.4	9.5	10.0	5	8	32	6	11.5
ARTHUR MAERSK	DANISH	23	52.4 N	155.3 W	18	18	35	.5 NM	62	1004.8	10.4			11.5			
SEALAND COMMERCE	AMERICAN	23	53.1 N	157.3 W	12	20	35	2 NM	62	1007.0	7.2	5.0	8	10			
ALVINA	LIBERIAN	23	53.6 N	175.4 E	18	30	M 35	5 NM	03	998.0	5.0	3.5	5	11.5			
ARCO FAIRBANKS	AMERICAN	23	52.9 N	136.7 W	00	32	M 36	5 NM	02	1020.7	11.0	7.8	3	6.5	31	< 6	11.5
GALVESTON	AMERICAN	23	54.7 N	137.1 W	00	29	35	5 NM	02	1021.3	10.0	8.9	3	6.5	29	8	14.5
SEALAND COMMERCE	AMERICAN	24	54.4 N	165.3 W	00	20	35	5 NM	01	989.2	7.2	5.5	6	8			
DAVID STARR JORDAN	AMERICAN	24	33.8 N	120.2 W	12	33	M 36	5 NM	00	1016.1	11.3	11.7			33	8	11.5
ARTHUR MAERSK	DANISH	24	52.4 N	162.2 W	06	22	38	.5 NM	28	998.8	8.0				24	12	16.5
MOBIL MERIDIAN	AMERICAN	24	57.6 N	142.2 W	18	14	45	5 NM	02		7.3	7.8	5	10	14	9	18
PRESIDENT MADISON	AMERICAN	24	54.0 N	160.0 W	12	23	M 35	10 NM	01	995.0	7.2	6.7	5	11.5	23	8	16.5
CHEVRON HAWAII	AMERICAN	24	57.9 N	149.5 W	06	15	35	2 NM	63	1000.0	6.1	5.5	4	8			
PORTLAND	AMERICAN	26	50.6 N	129.4 W	00	16	40	2 NM	51	1005.1	10.0	9.4	5	11.5	22	8	8
ALVINA	LIBERIAN	27	45.2 N	151.6 E	00	16	M 35	.5 NM	47	1006.0	3.0	2.0	7	13			
CRESSIDA	PANAMANIAN	27	51.9 N	139.0 W	12	27	M 40	10 NM	01	998.5	5.5		7	14.5	34	7	16.5
EXXON NEWARK	AMERICAN	27	51.1 N	135.7 W	18	27	35	10 NM	25	1009.0	8.2	8.3	5	6.5	27	9	10
ILLINOIS	AMERICAN	28	39.3 N	126.0 W	18	35	45	10 NM	02	1027.5	12.3	9.4	4	8	31	7	19.5
PRES CLEVELAND	AMERICAN	28	49.7 N	158.0 E	00	12	35	2 NM	02	1003.0	2.8	2.2	5	5	13	6	11.5
SAMUEL S	LIBERIAN	29	51.2 N	142.5 W	18	13	M 37	.5 NM	45	1022.0	7.0	7.0	4	6.5	14	11	11.5
AUSTRAL MOON	AMERICAN	29	40.2 N	124.5 W	18	34	M 50	10 NM	00	1017.0	11.2	7.2	5	29.5	36	12	29.5
GOLDEN ARROW	JAPANESE	29	53.2 N	151.1 W	18	07	M 36	1 NM	10	1010.5	7.0	7.5	3	6.5	09	6	10
ARILD MAERSK	DANISH	29	39.6 N	125.1 W	00	35	38	10 NM	01	1021.5	16.5	12.0	7	13			
DIANA PROSPERITY	SINGAPORE	29	32.0 N	124.2 W	00	35	M 40	5 NM	05	1016.5	18.5	14.0	8	8	33	9	11.5
HAWAIIAN MONARCH	AMERICAN	29	36.6 N	126.4 W	18	36	35	5 NM	02	1021.7	13.4	13.4	5	13	33	12	19.5
CHEVRON ARIZONA	AMERICAN	29	42.2 N	124.7 W	00	34	M 42	10 NM	02	1022.3	12.1		7	14.5			
ILLINOIS	AMERICAN	29	39.2 N	128.2 W	00	36	40	10 NM	02	1028.5	14.5	11.1	8	18	31	8	19.5
SANSINENA II	AMERICAN	30	41.2 N	126.0 W	06	36	36	10 NM	02	1020.5	12.2	10.0	3	10	36	6	18
SEALAND MC LEAN	AMERICAN	30	50.0 N	160.0 W	18	33	40	10 NM	02	1016.3	6.2	4.4	4	10			
ARCO PRUDHOE BAY	AMERICAN	30	50.4 N	147.9 W	06	13	35	2 NM	92	1012.2	6.0	6.1	6	14.5	15	7	19.5
AUSTRAL MOON	AMERICAN	30	41.8 N	124.7 W	00	35	M 55	5 NM	00	1018.2	12.2	7.2	5	29.5			
ARCO HERITAGE	AMERICAN	30	39.7 N	124.8 W	06	33	40	5 NM	02	1014.2	9.9	12.1	7	14.5			
AMER CHAMPION	AMERICAN	30	37.3 N	124.2 W	06	35	36	5 NM	02	1012.0	12.3	13.0	5	10	34	8	41
PRESIDENT MADISON	AMERICAN	30	36.9 N	143.1 E	06	18	M 45	2 NM	62	996.0	20.0	22.8	8	11.5	15	6	8
LAUREL	LIBERIAN	30	40.3 N	148.2 W	00	19	M 35	2 NM	05	1021.0	16.0	13.0	3	8			
EXXON PHILADELPHIA	AMERICAN	30	41.0 N	125.9 W	18	34	40	10 NM	05	1017.0	17.8	11.2	12	19.5			
GREAT LAND	AMERICAN	30	55.4 N	139.4 W	12	15	M 38	2 NM	62	1016.2	9.9	7.2					
PRES CLEVELAND	AMERICAN	30	39.2 N	136.6 E	18	30	35	10 NM	02	1002.0	11.1	12.2	6	8			
KEYSTONER	AMERICAN	30	18.4 N	100.1 W	18	11	65	5 NM	03	1005.1	25.0	28.3					
ARCO HERITAGE	AMERICAN	31	41.7 N	126.4 W	00	35	35	10 NM	02	1016.9	15.0	11.2	7	11.5			
EXXON PHILADELPHIA	AMERICAN	31	42.1 N	126.6 W	00	01	35	10 NM	05	1019.1	15.2	13.9	8	13	01	11	18
ALVA MAERSK	DANISH	31	17.1 N	101.5 W	06	07	35	.25 NM	65	1000.0	26.0						
PRINCE WILLIAM SOUND	AMERICAN	31	42.9 N	126.7 W	12	01	M 35	10 NM	02	1017.0	11.7	11.2	3	8			
PRES CLEVELAND	AMERICAN	31	38.3 N	135.1 E	00	27	35	10 NM	01	1005.8	15.6	14.0			30	< 6	8
LAUREL	LIBERIAN	31	42.0 N	165.5 W	23	23	M 35	1 NM	10	1019.0	11.0	12.0	3	6.5	25	6	10

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10°	Wind: Speed kt.	Visibility n. mi.	Present Weather code	Pressure mb.	Temperature °C: Air	Temperature °C: Sea	Sea Waves+: Period sec.	Sea Waves+: Height ft.	Swell Waves: Dir. 10°	Swell Waves: Period sec.	Swell Waves: Height ft.
NORTH PACIFIC OCEAN ENVIRONMENTAL BUOYS		MAY															
46001	AMERICAN	6	56.0 N	148.0 W	09	08	M 38			1011.0	3.7	4.4	9	14.5			
46003	AMERICAN	6	52.0 N	156.0 W	00	03	M 35			1001.9	2.7	3.7	7	10			
NORTH PACIFIC OCEAN		JUNE															
GREEN ECHO	LIBERIAN	1	51.7 N	144.0 W	00	20	M 35	5 NM	01	1019.5	11.0	5.0	9	11.5			
NAVASOTA	AMERICAN	1	18.6 N	120.0 E	00	21	M 35	2 NM	62	1007.0	27.2	30.0	2	5	23	7	6.5
ORIENTAL SOVERIGN	LIBERIAN	1	47.4 N	166.2 E	12	16	M 36	.25 NM	65	1004.5	7.5	4.0	9	14.5			
SEALAND MC LEAN	AMERICAN	1	48.8 N	173.6 E	18	15	35	10 NM	02	1012.8	4.7	2.8	4	8			
VAN WARRIOR	LIBERIAN	1	38.8 N	148.4 E	18	32	40	5 NM	03	1005.0	11.0	17.0					
PRES JOHNSON	AMERICAN	2	52.5 N	177.5 E	12	18	35	5 NM	00	1000.0	5.6	3.9	6	5			
SEALAND EXCHANGE	AMERICAN	2	29.7 N	128.8 E	06	12	35	2 NM	64	1005.2	21.1	23.0	6	10			
SEALAND MC LEAN	AMERICAN	2	48.1 N	170.3 E	00	19	36	5 NM	02	1001.0	7.0	3.0	5	10			
GLADIOLUS	LIBERIAN	3	51.8 N	169.6 E	18	26	M 36	2 NM		990.0	6.0	4.0			26	12	14.5
PRES WILSON	AMERICAN	3	52.8 N	178.1 E	18	22	35	5 NM	02	997.6	5.9	4.4	7	10			
TOYOTA MARU # 10	JAPANESE	3	51.8 N	177.5 W	18	23	M 38	1 NM	20	1007.0	7.0	6.0	3	6.5	08	7	14.5
SUNNY PIONEER	PANAMANIAN	3	49.6 N	172.6 E	12	24	M 45	2 NM	40	998.0	6.0	1.0					
WASHINGTON RAINBOW	JAPANESE	3	53.1 N	175.6 E	18	23	M 47	2 NM	07	989.0	7.5	4.0	6	10	23	9	16.5
PRES WILSON	AMERICAN	4	52.7 N	176.4 E	00	22	35	5 NM	02	996.1	6.6	4.5	5	13			
WASHINGTON RAINBOW	JAPANESE	4	53.0 N	172.5 E	06	23	M 35	2 NM	07	993.0	7.0	4.0	6	10	23	9	14.5
PRES JOHNSON	AMERICAN	5	41.8 N	150.3 E	06	15	25	2 NM	60	984.3	12.4	4.4	4	10	18	6	26.5
DITTE SKOU	DANISH	5	39.0 N	151.4 E	06	14	35	5 NM	58	994.5	19.0	18.0	5	8	14	8	10
ILLINOIS	AMERICAN	5	38.7 N	153.8 E	06	17	35	.5 NM	40	999.3	16.5	11.7	11	19.5			
TRANSCHAMPLAIN	AMERICAN	5	37.0 N	158.7 W	00	20	35	5 NM	60	1011.2	13.9	17.2	4	6.5	16	6	14.5
YOUNG SEAGULL	LIBERIAN	5	46.3 N	161.9 E	21	18	M 40	50 YD	62	994.0	9.0	4.5	5	6.5	14	< 6	10
SHINRYU MARU	JAPANESE	5	42.7 N	155.8 E	18	22	M 39	2 NM	07	992.0	13.5	7.0	8	8	22	8	11.5
WASHINGTON RAINBOW	JAPANESE	6	47.5 N	158.0 E	12	24	M 35	1 NM	52	987.5	4.5	3.0	7	11.5	23	< 6	14.5
SHINRYU MARU	JAPANESE	6	44.3 N	159.6 E	06	23	M 45	2 NM	07	996.0	12.5	2.5	10	8	23	8	11.5
BLUE OCEAN	JAPANESE	7	49.4 N	171.3 E	00	19	M 40	2 NM	03	999.0	5.0	4.0	4	13			
NOPAL LANE	LIBERIAN	8	07.6 N	92.9 W	12	12	M 37	> 25 NM	02	1011.0	26.5	27.0	3	3			
PRES PIERCE	AMERICAN	8	51.7 N	172.8 E	18	30	35	5 NM	02	1000.5	7.0	5.0	3	6.5	28	6	13
ASIAN ASSURANCE	LIBERIAN	9	53.7 N	179.2 E	00	27	M 40	2 NM	03	1000.2	7.5	5.0	14	13			
ASIAN ASSURANCE	LIBERIAN	10	50.7 N	165.7 E	12	18	M 41	< 50 YD	47	1000.3	6.9	4.5	15	16.5			
BLUE OCEAN	JAPANESE	11	37.3 N	144.0 E	12	18	M 40	.5 NM		1008.0	21.5	20.0	5	10			
SEALAND COMMERCE	AMERICAN	13	50.0 N	161.5 W	12	18	35	2 NM	63	1011.5	7.2	5.0	6	10			
PRES TRUMAN	AMERICAN	14	46.7 N	172.7 W	06	29	35	5 NM	02	1005.3	5.5	5.5	4	6.5	30	8	13
IRIS ISLAND	JAPANESE	14	49.3 N	163.8 W	12	22	M 41	200 YD	45	1003.0	6.5	6.0					
CHEVRON WASHINGTON	AMERICAN	14	53.8 N	159.8 W	18	20	M 36	1 NM	10	1000.4	6.1		3	8	20	7	16.5
CORNUCOPIA	AMERICAN	15	38.5 N	123.5 W	12	32	M 35	10 NM	02	1019.3	10.6	11.6	6	6.5	32	8	10
SEALAND FINANCE	AMERICAN	15	51.3 N	170.8 E	18	20	35	2 NM	10	1001.0	6.1	3.0	5	5	20	< 6	11.5
VAN WARRIOR	LIBERIAN	16	49.3 N	172.1 W	12	22	35	5 NM	03	1020.0	7.0	7.0					
MIDGETT	AMERICAN	17	54.6 N	162.6 W	06	21	M 36	2 NM	63	1010.1	6.9	7.0	2	6.5			
VAN WARRIOR	LIBERIAN	17	49.6 N	165.3 W	06	20	35	2 NM		1021.0	9.0	7.0					
PHILADELPHIA	AMERICAN	18	57.5 N	145.6 W	18	24	25	5 NM	18	1025.4	8.9	8.3	5	11.5	25	9	26.5
PRES PIERCE	AMERICAN	18	30.1 N	129.5 E	06	11	38	10 NM	02	1008.0	27.7	27.7	3	10	09	6	10
DEEPSEA MINER II	LIBERIAN	18	14.6 N	125.3 W	18	14	M 37	2 NM	81	1010.5	23.0	28.0	7	13			
S P LEE	AMERICAN	18	49.0 N	129.0 W	18	34	M 36	5 NM	03	1021.8	11.2	13.4	4	6.5	36	9	16.5
PHILADELPHIA	AMERICAN	19	58.2 N	148.2 W	00	24	28	5 NM	18	1022.3	9.4	8.3	5	11.5	22	9	24.5
PORTLAND	AMERICAN	19	50.8 N	129.9 W	00	34	45	10 NM	05	1023.4	15.0	11.1	6	16.5			
S P LEE	AMERICAN	19	49.2 N	129.3 W	00	34	M 38	5 NM	02	1024.2	12.2	12.2	5	8	36	9	19.5
SEALAND TRADE	AMERICAN	19	29.0 N	127.1 E	12	18	49	.25 NM		989.5	25.6	25.6	7	19.5			
ORIENTAL SOVERIGN	LIBERIAN	20	48.1 N	130.0 W	18	33	M 40	2 NM		1022.0	12.5	13.0	3	8			
OCEAN DUKE	KOREAN	20	48.1 N	170.1 W	06	11	M 38	.25 NM	58	998.0	9.0	5.0	5	5	11	8	13
SEVEN OCEAN	JAPANESE	20	50.3 N	169.5 W	06	13	M 36	.5 NM		1003.5	9.0	6.0	6	16.5			
SEALAND MC LEAN	AMERICAN	20	50.0 N	162.2 W	12	14	35	5 NM	51	1017.5	8.3	5.0	5	10	16	6	11.5
VAN TRIUMPH	LIBERIAN	20	50.4 N	161.8 W	12	16	M 35	200 YD	44	1021.0	8.0	7.0					
PACIFIC VENTURE	PANAMANIAN	20	42.9 N	166.9 W	06	16	M 46	1 NM	81	1010.5	13.5	10.5	10	23			
ORIENTAL SOVERIGN	LIBERIAN	21	49.1 N	133.1 W	06	32	M 40	1 NM		1025.0	11.5	13.0	3	8			
PRESIDENT MADISON	AMERICAN	22	46.5 N	162.3 W	12	29	M 35	2 NM	51	1031.4	10.6	11.7	5	8	29	8	6.5
GRAND CARRIER	LIBERIAN	23	45.4 N	173.6 E	18	21	M 35	200 YD	45	999.8	8.0	6.0					
GRAND CARRIER	LIBERIAN	24	47.6 N	175.0 W	18	24	M 35	2 NM	50	996.0	8.0	6.0					
PRESIDENT MADISON	AMERICAN	25	50.8 N	178.6 W	00	36	M 35	2 NM		1002.0	8.3	7.2	4	10	36	6	13
SEALAND COMMERCE	AMERICAN	26	50.3 N	146.8 W	12	27	35	5 NM	58	1024.0	10.0	8.3	8	10			
CHEVRON WASHINGTON	AMERICAN	26	40.1 N	124.4 W	12	34	M 47	10 NM	02	1011.4	12.5		5	11.5			
SEALAND COMMERCE	AMERICAN	27	52.2 N	152.4 W	00	29	35	5 NM	50	1021.5	8.8	7.2	8	10			
CHEVRON WASHINGTON	AMERICAN	27	42.6 N	126.7 W	00	36	M 38	10 NM	02	1013.2	15.7		5	10			
HONGKONG PHOENIX	SINGAPORE	29	49.8 N	129.6 W	06	32	36	10 NM	03	1016.0	12.0		7	11.8	14	10	8

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: The observations are selected from those with winds ≥ 35 kn or waves ≥ 25 ft from May through August (≥ 41 kn or ≥ 33 ft, September through April). In cases where a ship reported more than one observation a day with such values, the one with the highest wind speed was selected.

Rough Log, North Atlantic Weather

August and September 1978

ROUGH LOG, AUGUST 1978--The primary concentration of low-pressure centers was along a path from west of Lake Winnipeg to Labrador and then across Iceland. A secondary path branched northeastward over the province of Quebec to the Labrador Sea. A climatological track along the St. Lawrence River valley did not exist. One storm center traveled southeastward across the Great Lakes, moved northeastward off the East Coast, and ended over the Denmark Strait. Two storms turned southward when east of Newfoundland.

As is expected during a summer month, the primary feature over the ocean was high pressure. The Bermuda-Azores High was 1024 mb near 30°N, 38°W. This was only 1 mb higher and 300 mi south of its climatic pressure and position. A significant feature was a ridge of higher than normal pressure--about 4 mb--that projected northeastward to the English Channel. A 1007-mb LOW was near Lake Harbour on the Hudson Strait, while the primary 1005-mb LOW was shifted northward, north of Ellesmere Island.

The two primary anomaly centers that influenced marine weather were both positive. One was 6 mb and centered off Ireland in connection with the higher pressure of the aforementioned ridge. The other was a larger, less intense area of 3 mb that stretched from Florida to Newfoundland. The displacement of the primary LOW resulted in a minus 7-mb anomaly west of Ellesmere Island. The two storms that traveled southward over the ocean resulted in a minus 2-mb anomaly center over the central area--42°N, 35°W.

The mean 700-mb surface was radically different in pattern from climatology. Zonal flow stretched from the west coast of North America to midocean near 40°W before turning northeastward to form a slight ridge over the east coast of Europe. There are normally troughs along the North American east coast and European west coast.

There were four tropical cyclones this month. They were tropical storms Bess and Debra and hurricanes Cora and Ella.

Extratropical Cyclones--As the month began a LOW was passing over Kap Farvel. The usual front was wrapped around its east side and trailing more toward the south than west, breaking the HIGH into two centers. On the 2d the northern center moved rapidly eastward following the front. By 1200 of the 3d the chart showed that a 1016-mb frontal wave had developed near 46°N, 42°W. The center moved southward and the circulation enlarged (fig. 45). At 1800 on the 4th the WORTH (38°N, 40°W) was 250 mi southwest of the center with 45-kn westerly winds in showers. Her report also indicated 33-ft swells. At 0000 on the 5th the BOOKER VANGUARD was very close to the same spot with lightning, but the winds were only 25 kn and the swells 16 ft. The surface LOW had now built up to the 700-mb level. At midday the LUDWIGSHAFEN was north of the center with 35-kn gales from 060°.

On the 6th and 7th the LOW circled clockwise around a center near 37°N, 39°W. Late on the 7th it

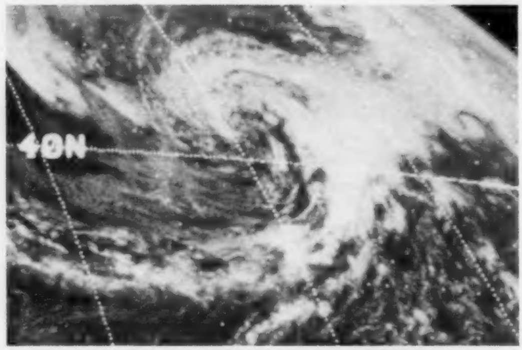

Figure 45.--This SMS GOES image for 1800 August 4 shows the storm centered near 40°N, 40°W.

lost its upper air support and drifted northeastward to completely dissipate late on the 8th. The lowest pressure the storm attained was 1010 mb on the 4th.

A weak stationary front stretched east to west across the Mediterranean Sea on the 6th. A HIGH off the coast of Portugal consolidated into one center on the 0000 chart of the 7th, and by the 0600 chart a frontal wave had formed off of Barcelona. All this tended to increase the northerly circulation (fig. 46). At 1200 the coastal town of Alicante, Spain, was measuring 30-kn winds. The airport at Tripoli, Libya, had 35-kn scorching winds out of the south. At 1800 two ships in the vicinity of 32°N, 10°W, off the Moroccan coast had northerly winds between 40 and 45 kn with seas up to 13 ft. The ROUSSILLION, south of Marseille, had 45-kn winds from the northwest at 0000 on the 8th. The

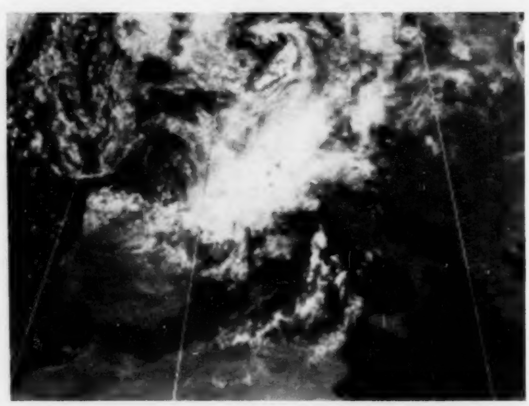

Figure 46.--Most of the cloudiness is over France and north of the Alps as the storm builds early on the 7th.

DOVER CASTLE was off the west coast of Corse at 1200 with 40-kn westerly winds, 13-ft seas, and 25-ft swells. At this time the 992-mb LOW was over Berlin. The storm continued northeastward and no longer affected the marine area.

Northern Italy was hit by flash floods, tornadoes, and the first August snow in half a century. In the south a hot sirocco wind fanned forest fires. Twelve bodies were found and 10 people were missing. Most of the continent had suffered a wet summer. Blizzards and other freak weather in the Swiss Alps contributed to the death of more than 30 Alpine climbers during the previous few weeks.

A storm came out of Labrador on the 6th and moved northeastward across the Labrador Sea. Another center was analyzed farther south in the trough on the 0000 chart of the 8th. At 1200 a SHIP near 45°N, 44°W, reported 50-kn winds. The BEN OCEAN LANCER was off Hamilton Inlet at 1800 with 35-kn winds and 13-ft seas and swells. The storm was tracking eastward, and the circulation was becoming better organized. At 1800 on the 9th, three ships reported high winds east of Newfoundland. The SELFOSS reported the highest of 58 kn. The SIR W. ALEXANDER was south of Halifax with 40-kn gales. On the 10th the storm was 994 mb. Two ships along longitude 42°W near latitudes 50° and 58°N had 37-kn gales. An Icelandic ship was northeast of the center on the 11th with 38-kn gales. On the 12th the center dissipated into a trough.

Monster of the Month--On the 13th an east-west front crossed the U.S. Atlantic coast near Delaware Bay. A series of shallow waves were indicated on the analysis. On the 0000 chart of the 14th a 1014-mb unstable wave was analyzed near 42°N, 59°W. At 1200 the CETRA CARINA (39°N, 58°W) was south of the cold front with 40-kn southwesterly winds and heavy rain.

As the storm moved east of Newfoundland and south of Kap Farvel, it quickly intensified. At 1200 on the 15th the pressure was 993 mb (fig. 47). Several ships reported gales. The highest noted was 52-kn storm winds by the SIR HUMPHREY GILBERT near Belle Isle. The highest seas for the day were 20 ft reported by the ASIA LINER near 47°N, 35°W.

At 1200 on the 16th the center of the storm passed very close to Ocean Weather Station Charlie. His pressure was 984.9 mb, while the central pressure on the analysis was estimated as 980 mb. The winds were in the 35- to 40-kn range and the seas 18 ft. The LUDWIGSHAFEN (48°N, 37°W) approximately 250 mi to the south of the center (52.5°N, 37°W) reported 45 kn and 20 ft.

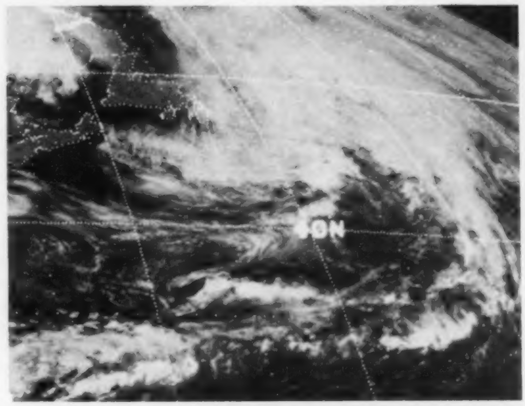

Figure 47.--The storm was caught off Newfoundland with its center near 49°N, 42°W.

The storm continued to deepen as it traveled northward. Its lowest pressure was 970 mb at 1200 on the 17th, quite low for this time of year for an extratropical storm. At 0000 the BAKKAFOS was on the western edge of the storm with 55-kn northerly winds. At 1200 a U.S.S.R. ship near 53°N, 55°W, reported 58-kn winds out of the north. OWS Charlie measured gale-force winds with 18- to 20-ft seas. The storm's cyclonic circulation dominated the sea from Newfoundland to Ireland and Iceland to latitude 40°N. From 1800 on the 17th to 1200 on the 18th Charlie measured 40- to 48-kn winds with seas peaking at 26 ft. The AYAKS (52°N, 34°W) reported 54-kn winds and 20-ft seas. Late on the 18th the ANTCHAR (55°N, 36°W) contended with 54-kn winds, 36-ft seas, and 30-ft swells. A U.S.S.R. ship and the MATKO LAGINJA both found winds of 70 kn or more from the west. Charlie was rolling with 23-ft swell waves.

By the 19th the storm was beginning to weaken as the central pressure rose. This was of little consolation to the DELTA DRECHT, which was sailing eastward along latitude 60°N with 23-ft swells pounding her starboard beam. The storm moved over Iceland on the 21st and into the Norwegian Sea. Although a weak storm, it turned northward on the 23d and ended its career over the Svalbard Islands on the 25th.

A storm that developed a day earlier over Saskatchewan, Canada, moved over Baffin Bay on the 21st. As the front moved past Kap Farvel, a LOW formed off the southeast coast of Greenland. The first chart to show this was the 0000 chart on the 22d. The LOW tracked northeastward along the Greenland coast. It turned eastward over Scoresby Sound on the 23d. At 1200 the GRONLAND, east of Kap Farvel, reported 35-kn winds. The SEMAC was at 61°N, 02°E, on the 24th with gale-force winds (fig. 48). Later in the day the winds had increased to 44 kn, and other ships joined in with gale reports and seas up to 13 ft.

The initial LOW deteriorated over Nordkapp on the 25th, but a new center developed over Helsinki at the same time, continuing the northwesterly flow over the Norwegian and North Seas. At 0600 the ESSO WARWICKSHIRE was midway between the Shetland Is-

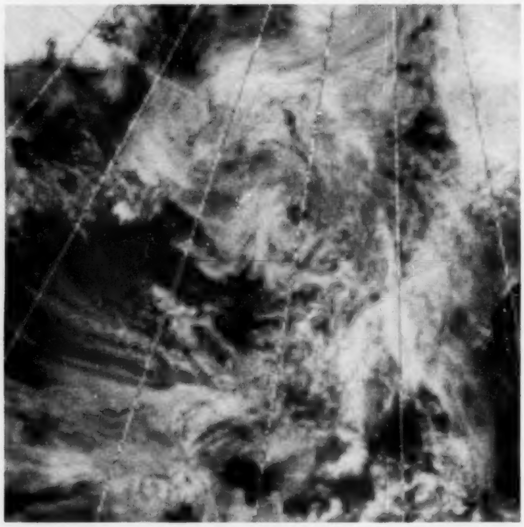

Figure 48.--The cloud pattern is very diffuse with no predominant center. The surface analysis indicated it was near 70°N, 00°.

lands and Norway with northwesterly winds of 38 kn and waves of 20 ft. At 1200 she had 48 kn. The LOW was nearly stationary over the Gulf of Finland as was a HIGH west of Scotland. This continued the northwesterly flow with winds of gale force until the 28th.

This storm can be traced to the mountains of Idaho, where it was first analyzed on the 20th. It traveled across the northern United States and southern Canada mostly as a frontal wave. As it moved over the Strait of Belle Isle on the 24th, it deepened and the closed circulation expanded rapidly. At 1200 the 997-mb LOW was near 51°N, 51°W. The FALCON was about 400 mi to the southeast near the warm front with 40-kn winds out of the south. Late in the day the storm turned northward.

On the 25th the BEN OCEAN LANCER was sailing northward from near Hamilton Inlet into the Davis Strait. At 0000 it had 41-kn northerly winds that increased to 53 kn by 1800. The waves were 15 to 18 ft. Another SHIP in the area had 48 kn, and Kap Farvel measured 40-kn winds. At 0000 on the 26th the LANCER had 50-kn winds with waves building to 21 ft. On the 27th the LOW stalled near Cape Chidley.

Tropical Cyclones--Tropical storm Bess developed on the 6th in the western Gulf of Mexico, some 250 mi east-northeast of Tampico. This short-lived storm headed west-southwestward and intensified. Winds near her center climbed to 45 kn, with gales extending out 100 mi to the east and a short distance to the west. As Bess moved to within 60 mi of Tampico on the 7th, she turned toward the south. The following day she moved ashore south-southeast of Tuxpan. Later in the day the remnants of the storm dissipated over the mountains of eastern Mexico between Tuxpan and Vera Cruz.

While Bess was crashing the Mexican coast, Cora was organizing west of the Cape Verde Islands (fig. 49). She began as a disturbance off the northwest African coast. On the 7th she organized into the third depression of the season. The following day she was christened tropical storm Cora, and by that afternoon she reached hurricane intensity. Cora was moving westward at about 20 kn. By the 9th, while still east of the Lesser Antilles, the circulation of Cora became disorganized and her eye was no longer evident. The first reconnaissance flight, which took place that afternoon, reported 1008-mb pressure and sustained 55-kn winds in squalls. Cora was dissipating as fast as she had intensified. On the 10th she moved through the Windward Islands bringing 40-kn plus winds to St. Lucia and Barbados. The following day Cora lost all evidence of circulation and was downgraded to a tropical wave. During her brief tenure as a hurricane, satellite photographs indicated a 980-mb pressure and maximum winds of 75 to 80 kn early on the 9th.

Debra was spotted as a tropical depression in the

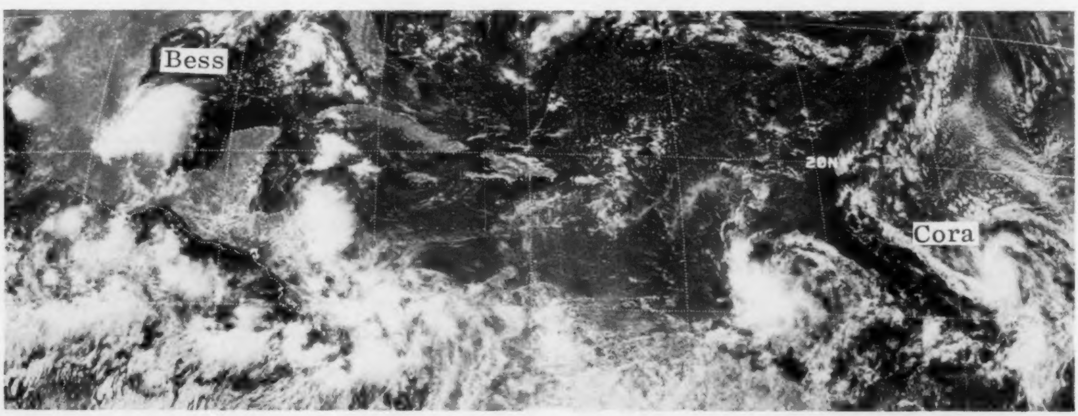

Figure 49.--At noon on the 7th, Bess is moving ashore on the Mexican coast, while Cora is getting it together about midway between Africa and South America.

northwestern Gulf of Mexico late in the month. She reached tropical storm strength on the 28th about 100 mi south of Port Arthur, Tex. This was confirmed by the TRANSPANAMA and the ATLANTIC HERITAGE, when they encountered 37- to 40-kn winds in 13-ft seas; the former was within 90 mi of the center at 1800 on the 28th. The EXXON NEWARK ran into 38-kn winds 6 hr later near 27.3°N, 91.5°W. Highest sustained winds near Debra's center were estimated at 48 kn as she moved ashore near the Texas-Louisiana border during the evening of the 28th. The slow-moving storm dumped heavy rain totalling up to 7 in on southern Louisiana (fig. 50). Even though Debra weakened rapidly, her remnants produced tornadoes and heavy rains through the Delta States to northern Arkansas and extreme western Tennessee. At least eight tornadoes were sighted in Mississippi, and a late-evening twister struck Memphis.

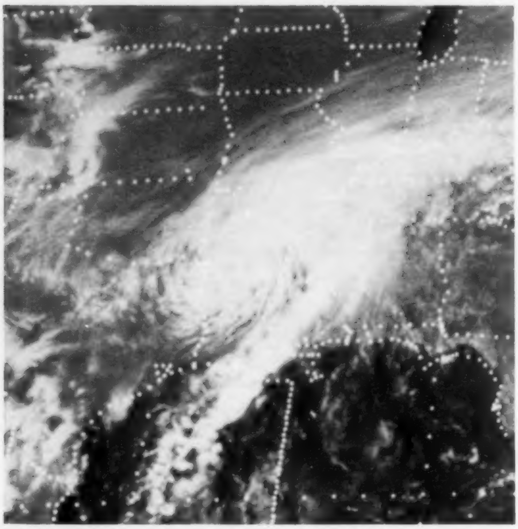

Figure 50.--Debra still retains remnants of her tropical heritage on the 29th after moving ashore and dumping heavy rain on the area.

While Debra was dying in the south, Ella was coming to life south of Bermuda. By the 30th Ella reached tropical storm strength some 300 mi south of Bermuda. She was heading west-northwestward toward the U.S. East Coast about the time that thousands of vacationers were getting ready for a last summer fling at the seashores over Labor Day weekend. The stage was set for a potential disaster -- the U.S. East Coast had gone 18 yr without a devastating hurricane. Ella reached hurricane intensity on the 31st. During the day winds continued to strengthen. By evening winds were up to 80 kn, and Ella was some 525 mi southeast of Cape Hatteras. On Friday morning (September 1) a hurricane watch was posted along the vulnerable, soon to be crowded, Outer Banks of North Carolina. Tension was mounting along the entire northeast and mid-Atlantic coast. By noon Ella crept to within 325 mi east-southeast of Cape Hatteras. Maximum sustained winds near her center climbed to near 90 kn.

One good sign was a slowing of her forward speed--often an indication of turning. As traffic poured into the resorts, Ella paused about 315 mi southeast of Hatteras on Friday evening. Her central pressure was down to 960 mb, while 90-kn winds remained close to her eye. By midnight winds reached 105 kn, but it was obvious that Ella would recurve toward the north and then northeast on Saturday. During the morning Ella stalled and remained in the same area for most of the day--about 300 mi southeast of Hatteras. Finally, about midnight the watch was lifted as Ella began to accelerate northeastward. She had weakened some, but maximum winds were around 75 kn. Ella paralleled the East Coast as she moved northeastward at about 15 to 20 kn. Winds climbed to 100 kn as she reintensified on the 3d (fig. 51). Her forward speed jumped to 35 kn.

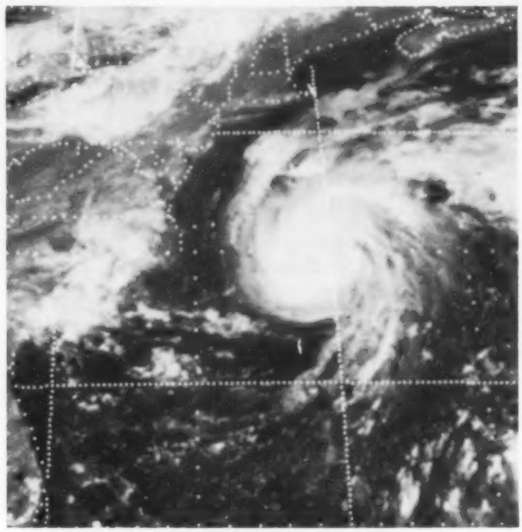

Figure 51.--It was lucky for the U.S. East Coast that Ella curved northeastward off the coast, instead of hitting the holiday crowded beaches.

By the 4th Ella was threatening Newfoundland. Her winds reached 120 kn just southeast of her center. Several ships felt the wrath of Ella's fury. On the 5th, after she clipped Cape Race, Ella pounded the ST. LAWRENCE PROSPECT with 65-kn winds. Her central pressure had reached a low of 956 mb earlier. Gradually, the rapidly moving system began to weaken as it turned east-northeastward on the 5th. Cold air was also causing Ella to turn extratropical.

Casualties--The 166-ft fishing boat R. L. HANEY, JR. capsized and sank about 12 mi south of Biloxi, Miss. Of the 15 crewmembers, 1 drowned and 2 were missing. The seas were 6 to 7 ft with 20-kn winds at the time the boat was reported to have had a full load of fish. Another fishing boat, the GEORGIA BABY, rescued seven of the crew.

ROUGH LOG, SEPTEMBER 1978--The major storm track across the North Atlantic was near the climatological mean. Climatology indicates two tracks passing over Newfoundland, with the northern one continuing to Iceland and the southern one to the Faeroe Islands. This month the mean track would follow a course between the two except off the Labrador Sea. In this western area a track came east out of Labrador and another northeastward from Newfoundland. The paths of storms leading to the salt water were vastly different from climatology. The storms mostly originated over the eastern slopes of the Rocky Mountains of southern Canada and northern United States and tracked eastward. Climatology indicates a northeastern track out of the United States and off the East Coast. No storms formed off the East Coast this month.

As usual, the most prominent feature in the mean pressure pattern was the Azores High. The significant feature of this HIGH this month was its 1025-mb center, which was displaced over 700 mi to the northeast of its climatic position. The center was near 43°N, 19°W, and 4 mb higher in pressure than normal.

The 1003-mb Icelandic Low was near 61°N, 26°W, only a relatively few miles from the normal position and 2 mb lower in pressure. There was an anomalous 1004-mb LOW over the Gulf of Bothnia. The pressure along the east coast of North America was near normal.

The most significant anomaly center was plus 8 mb near 47°N, 10°W, associated with the Azores High. This center particularly influenced the area bounded by 40° to 60°N and 30°W to 10°E. The largest negative anomaly center was minus 8 mb over the Gulf of Finland. Over the open ocean the largest negative anomaly was 4 mb south of Kap Farvel near 53°N, 47°W.

In the upper air at 700 mb the long-wave trough was alined along longitude 57°W and much sharper than normal. There was a ridge over the west coast of Europe, rather than the usual short-wave trough.

There were three tropical cyclones--hurricanes Flossie and Greta and tropical storm Hope.

Extratropical Cyclones--There were several significant storms this month along the northern shipping lanes. The first of these formed over James Bay on the 4th. It moved east-southeastward and crossed into the open water over Cabot Strait following behind hurricane Ella.

By the 7th the LOW was 986 mb near 50°N, 43°W, at 0000. Ocean Weather Station Charlie had 18-ft waves. By 1200 this LOW had absorbed what remained of the circulation of Ella. The German fishing vessel TEUTONIA was near 62°N, 40°W, with winds exceeding 50 kn out of the north. She did not report the seas. To the south of the 978-mb LOW (1200 analysis) a SHIP was battered by 30-ft swells. Ahead of the storm Lima measured 18-ft swells. The 1800 report of the ATLANTIC CONVEYOR (47°N, 39°W) indicated westerly winds of 78 kn, but no wave reports.

The C.P. DISCOVERER found 54-kn westerly winds near 52°N, 30°W, at 0000 on the 8th. This was about 350 mi south of the storm's center. The waves were 20 ft. Fishing boats south of Iceland were finding winds above 40 kn. At 1200 the PETREL was near Fastnet Rock with 45-kn gales and 23-ft seas (fig. 52).

As the storm moved over the Norwegian Sea, it weakened rapidly and finally disappeared over Finland on the 12th.

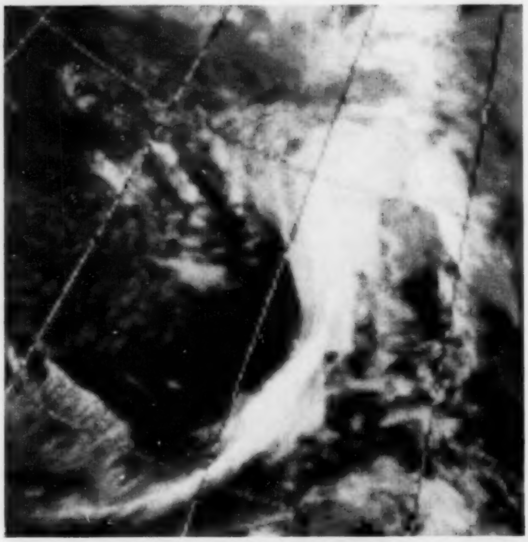

Figure 52.--The sharp cold front was almost directly over Fastnet Rock at the time of this image on the 8th. (DMSP Imagery)

Monster of the Month--A weak LOW had formed near Quebec on the first chart of the 9th. As it moved over open water, it intensified rapidly. The fishing trawler CAPT. COSMO was last heard from late on the 8th; it had reported 15- to 20-ft seas while fishing off Georges Bank. The boat was due in port on the 9th. The Coast Guard found no trace of the boat or crew. Other fishing boats reported the winds and seas increased overnight and the next day. By 0000 on the 10th the LOW was 992 mb. At 1200 the pressure was 960 mb. The ASIA HAWK (46°N, 51°W) had northerly 53-kn winds and a pressure of 987 mb. The EUROLINER (43°N, 50°W) had southwesterly 58-kn winds and a pressure reading of 960 mb. The swell waves were 30 ft.

The tightly wound storm continued a northeasterly track. At 0000 on the 11th the ZEALANDIC (46°N, 43°W) encountered 55-kn southwesterly winds. Six hours later the winds were 60 kn and the swells 33 ft. At 1800 the QUEEN ELIZABETH 2 was in the southeast quadrant of the storm (figs. 53 and 54) and was battered by 60-kn winds out of the southwest and 39-

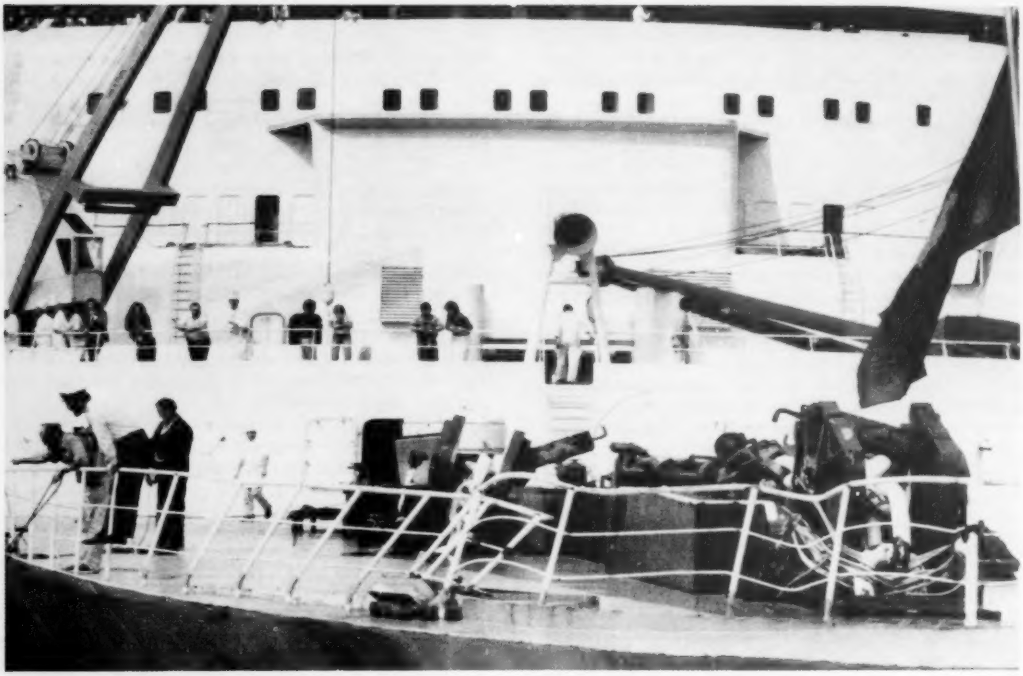

Figure 53.--This photograph taken after the QUEEN ELIZABETH 2 docked in New York shows the power of the sea and the damage it inflicted. <u>Wide World Photo.</u>

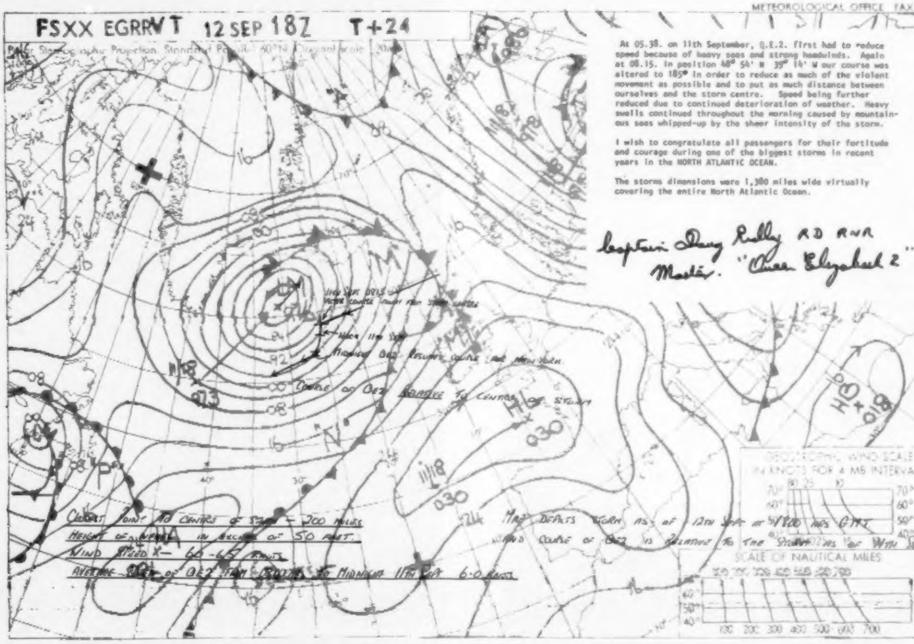

Figure 54.--This prognostic chart was received aboard the QUEEN ELIZABETH 2 by facsimile. The chart was posted on the ship by Captain Ridley.

ft swells. Her pressure dropped to about 991 mb. The ship's log indicated she started encountering the heavy swells on the 10th. The wind increased to force 12 during the morning of the 11th with very heavy southwesterly seas and swells. Near noon ship time, a rough sea hit the starboard bow and damaged the rail and port platform. Early on the 12th the seas gradually subsided and the ship was able to slowly increase speed. About 20 out of 1,213 passengers were injured, and damage was estimated at $50,000 including bent bow rails and torn hull plates.

The high winds and seas continued through the 12th although the storm was weakening. Charlie measured 45-kn winds and 26-ft seas. A vessel near 54°N, 36°W, had 60-kn winds. The IXIA (56°N, 29°W) also had 60 kn and 39-ft seas and swell waves. Charlie reported 30-ft swells at 1800.

On the 13th the 980-mb storm swept the southern coast of Iceland. Ocean Weather Station Lima reported winds of 46 kn and seas of 20 ft. As the storm crossed the Norwegian Sea, ships there and on the North Sea reported winds in the 40-kn category and waves up to 25 ft. As the LOW approached the coast of Norway on the 15th, it suddenly turned northward and ended over the Barents Sea.

On the 14th a storm was approaching the southwest coast of Greenland across the Davis Strait, and another storm moved toward Iceland. Both storms dissipated into other circulations, and at 1200 on the 15th another LOW was analyzed off the southeast coast of Greenland. By 1200 on the 16th the 980-mb storm was at 62°N, 10°W (fig. 55). Lima measured 40-kn winds and 16-ft waves. Many ships on the North and Norwegian Seas reported during this period. Several had winds near 50 kn, but the GTOT had the highest waves. She reported 39-ft seas and swells of 41 ft near 57°N, 11°W. A station on the Outer Hebrides measured 40-kn southerly winds.

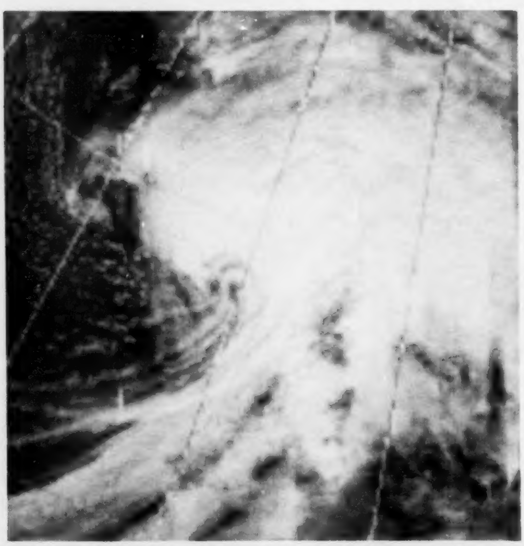

Figure 55.--This visual composite early on the 16th shows the upper air center near 58°N, 10°W. (DMSP Imagery)

The storm moved ashore over central Norway on the 17th. The many ships and platforms in the North and Norwegian Seas were all reporting winds over gale strength, with many over 50 kn. A ship with the call letters RIGG reported 74-kn winds and 25-ft seas near 61°N, 01.3°E, at 0600. The highest seas appeared to be 33 ft in the same general area. At 1800 the POSEIDON (63°N, 05°E) had roaring 60-kn winds and 30-ft seas. As the storm continued inland, the reports rapidly dropped off, and by the 18th the storm was no longer of concern to the mariner.

Gillette, Wyo., was the birthplace of this storm late on the 18th. It crossed the Labrador coast on the 21st. At 1200 on the 22d the storm was 980 mb and south of Kap Farvel. A SHIP was within sight with 52-kn northeasterly winds, 26-ft seas, and a pressure of 989 mb. The circulation extended eastward to the fishing grounds south of Iceland, where five Icelandic fishing boats reported winds in the 40-kn range. On the 23d the highest wind was 52 kn reported by the GODAFOSS (55°N, 50°W) south of Greenland, and the highest waves were 25 ft reported by the C.P. VOYAGEUR (52°N, 45°W). The RIGOLETTO encountered 58-kn winds and 30-ft swells on the 24th near 58°N, 18°W.

As the storm moved across Iceland on the 25th, it stalled off its east coast for about 24 hr before moving into Norway and finally dissipating.

This LOW formed over the Gulf of St. Lawrence on the 25th. It almost dissipated on the 26th, but a shortwave trough in the upper air changed to a closed LOW, and the surface LOW rapidly intensified on the 27th. At 1200 on the 28th the central pressure was 984 mb

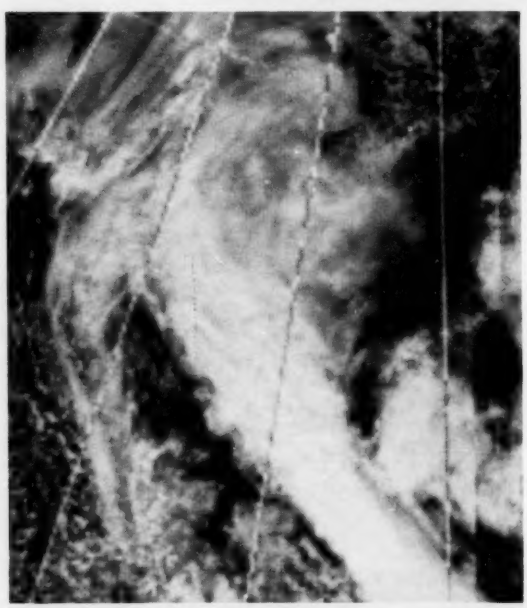

Figure 56.--Ocean Weather Station Lima probably was under the influence of the instability cloud through 60°N, 12°W, when she experienced the 54-ft swells. (DMSP Imagery)

near 61°N, 15°W. The C.P. DISCOVERER (57°N, 20°W) was sailing into 50-kn westerlies and 23-ft waves. Lima measured 20-ft seas. The report from "OWS LIMA" for 0000 on the 29th indicated 40-kn winds, 18-ft seas, and 54-ft swells (fig. 56).

As the storm moved into the North Sea, the many ships and platforms reported gales of around 40 kn. Most of the seas were 10 to 20 ft. Lima's wave report had dropped to 20 ft. The storm crossed inland west of Denmark on October 1 letting the North Sea relax.

Lake Huron spawned this storm on the 27th. It deepened rapidly on the 29th as it moved over the Gulf of St. Lawrence and produced a few gale reports. On the 30th the CAST BEAVER (53°N, 44°W) was hit by 45-kn southwesterly winds with 23-ft waves. A station on the southern coast of Newfoundland measured 40-kn winds. The SMELYY off Hopedale had bone-chilling 50-kn northerly winds at 5°C. Her 0600 report indicated 74 kn with a pressure of 981 mb. Late this day the storm's center crossed Kap Farvel at 970 mb.

On October 1 several ships reported 50-kn winds with many in the 40's. Among them was the GRONLAND (59°N, 39°W) with 52 kn and 33-ft seas. At 0600 on the 2d the FRITHJOF (65°N, 35°W) had 50-kn northerly winds and 36-ft waves, and at 1800 the ANNE JOHANNE (61°N, 25°W) braved 60-kn westerly winds. Other ships were reporting waves up to 25 ft (fig. 57). The BAMSA DAN had hail showers near 61°N, 18°W. On the 3d the FRITHJOF had 60-kn winds from the west with the seas still running at 36 ft. Lima was measuring winds over 40 kn, and the seas were in the vicinity of 25 ft. On the 4th the storm was over the Norwegian Sea at 984 mb. Fishing boats, ships, and rigs south into the North Sea had gales. The storm crossed into central Norway on the 5th, and a coastal station had 50-kn winds more due to funneling in a fjord than the pressure gradient.

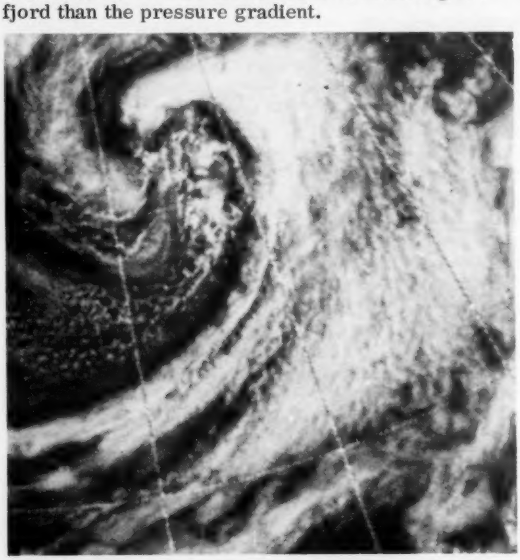

Figure 57.--This is how the storm looked from space near midday on October 2. (DMSP Imagery)

Tropical Cyclones--Hurricane Flossie developed some 1,300 mi east of the Lesser Antilles on the 4th. As a tropical storm, she moved northwestward at about 12 kn. She turned westward after crossing the 20th parallel early on the 6th. Winds near her center were 45 kn. When 600 mi northeast of Puerto Rico, Flossie recurved toward the northeast and weakened. After several days as a tropical depression, she regained storm strength. By the 12th, near 31.5°N, 43.5°E, Flossie was a hurricane. This was supported by the POINTE SANS SOUCI, which encountered 50- to 60-kn winds on the 13th within 100 mi of the storm's center. At 1200 the ship ran into 36-ft seas. The BREMERHAVEN also encountered 60-kn winds while rolling in 26-ft seas. Winds near Flossie's center were estimated at 80 kn (fig. 58). Moving north-northeastward for several days, the gradually weakening storm passed about 400 mi west of the Azores; and it was finally absorbed by a large extratropical low northwest of the British Isles.

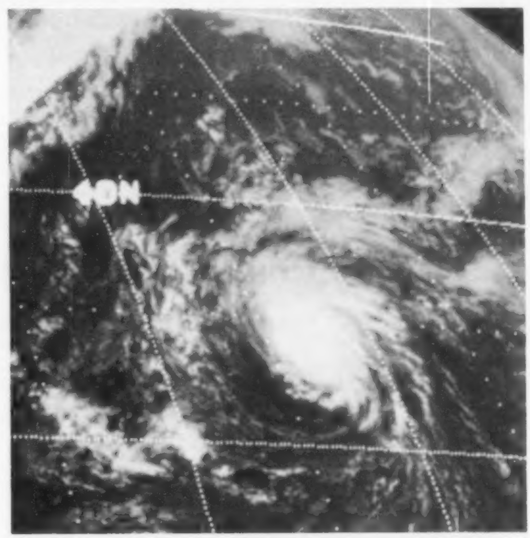

Figure 58.--Hurricane Flossie is sporting 80-kn winds. Two ships encountered 60-kn winds and 26-ft seas.

Meanwhile, north of the Venezuelan coast near Caracas, Greta was developing from a strong tropical wave. She moved west-northwestward and intensified. Greta reached hurricane strength on the 16th about 275 mi south of Jamaica. Winds of 75 kn blew around a 989-mb center. She was heading toward Nicaragua and Honduras. By the 17th winds were near 90 kn, and the central pressure had dropped to 970 mb. By 1900 Greta was 40 mi northeast of Cape Gracias, where winds were blowing at 35 kn from the north (fig. 59). A few hours later the wall cloud was on the coast of Honduras as Greta skirted the east coast. Central pressure was down to 952 mb with winds estimated at 110 kn. Pressure dropped to 947 mb early on the 18th as Greta's center was located about 65 mi to the east of Guanaja Island. Strong winds, high tides, and torrential rains battered northern Honduras and the offshore islands. By afternoon Greta showed signs of

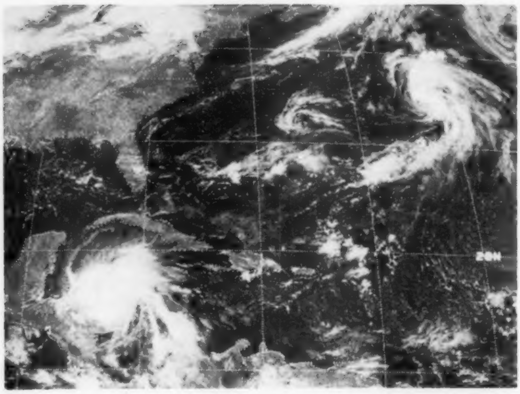

Figure 59.--Hurricane Greta is pounding Nicaragua and Honduras at 1700 on the 17th. The next day the pressure dropped to 947 mb. Hope was organizing near 35°N, 50°W.

weakening under the influence of land as she crossed the island of Roatan on her way toward Belize. Packing winds of 95 kn, Greta crossed the coast during the night of the 18th directly over Stann Creek, which reported 82-kn winds. Belize City felt 61-kn winds, and portions of the city were under 8 ft of water. The following day the weakening storm moved through northern Guatemala and into Mexico. That evening Greta was weakening about 200 mi northwest of Guatemala City over the rugged terrain of Mexico. However, she survived to become eastern North Pacific hurricane Olivia.

For several days a broad area of low pressure with cloudiness and showers meandered northeastward from near the Florida-Georgia coast. Finally, on the 14th it organized into a tropical depression some 225 mi northwest of Bermuda. It turned eastward and then east-southeastward. Finally, on the 16th, it began a northeastward course. On the 17th about 650 mi east-northeast of Bermuda, tropical storm Hope was born. She moved northeastward at 12 kn, and her winds increased to 55 kn on the 18th. She was now following a course similar to Flossie of less than a week before. Hope passed about 500 mi northwest of the Azores on the 19th. As with her predecessor, Hope was absorbed by an extratropical low.

Casualties--The 7,063-ton Japanese cargo vessel ANGEL sank after she was cut in two in a collision with the 8,634-ton Greek cargo vessel DIGNITY in thick fog about 24 mi northwest of Leixoes, Portugal, on the 20th. Thirteen crewmembers from the ANGEL were rescued and 11 were missing. The DIGNITY sustained severe bow damage and was towed by the tug MONTE XISTO to Leixoes.

Rough Log, North Pacific Weather

August and September 1978

OUGH LOG, AUGUST 1978--The mean storm tracks this month differed considerably from the climatic mean. Normally, there is a track out of Asia across the Gulf of Terpeniya to the Kurile Islands. Another track heads northeastward from about 600 mi off Tokyo to the Aleutians near 180° and then eastward into the Gulf of Alaska.

This month the mean track moved eastward from the vicinity of Hokkaido to near 45°N, 170°E, and then curved sharply northeastward toward Bristol Bay. A secondary track came across the Sea of Okhotsk to the Bering Sea.

The main pressure feature was the Pacific High at 1026 mb centered near 40°N, 150°W. This is within a few miles and 2 mb of being normal. The Aleutian Low is normally 1008 mb near 60°N, 175°E. This month it was 1002 mb near 56°N, 167°E.

The anomalies south of 40°N were generally positive and only 0 to 3 mb. There were two negative anomaly centers north of 40°N. The largest was minus 7 mb and collocated with the position of the Aleutian Low. The other was minus 4 mb and centered near 50°N, 140°W.

In the upper air at 700 mb the main feature was a closed-Low center corresponding to the Aleutian Low. This is normally only a trough out of the Polar Low. A second closed-Low center was over the Gulf of Alaska near 55°N, 143°W. This last center was truly anomalous as there is usually a ridging effect in this area. The closed LOW over the Bering Sea produced a pronounced ridge over western Alaska. The LOW over the Gulf of Alaska accentuated the usual trough off the North American west coast.

There were six tropical cyclones over the eastern ocean--four hurricanes and two tropical storms. In the western ocean, there were seven tropical cyclones of which three were typhoons and four were tropical storms.

Extratropical Cyclones--The month began with two tropical cyclones straddling Japan. Wendy came in from the west toward Kyushu, and Virginia traveled northward off the east coast. By the 3d both had deteriorated to tropical depressions. By 1200 both had been dropped from the analysis. At this time a LOW developed over the Sea of Japan west of Hokkaido.

At 0600 on the 4th the NIKOLAI ISSAIENKO was off Nemuro with 40-kn southwesterly winds. The storm moved east-northeastward and at 0000 on the 5th was 983 mb near 49°N, 155°E, over the Kurile Islands. The weather station on Ostrov Urup measured 35-kn winds. On the 6th there were many reports of gale-force winds. Early in the day the ORIENTAL SOVEREIGN was very near the storm's center with a pressure of 985 mb and 42-kn winds. The center of the storm was estimated at 983 mb (fig. 60). Not too far away the IONIAN LEADER reported 33-ft seas. At 1200 the SCHERPENDRECHT (47°N, 172°E) was about

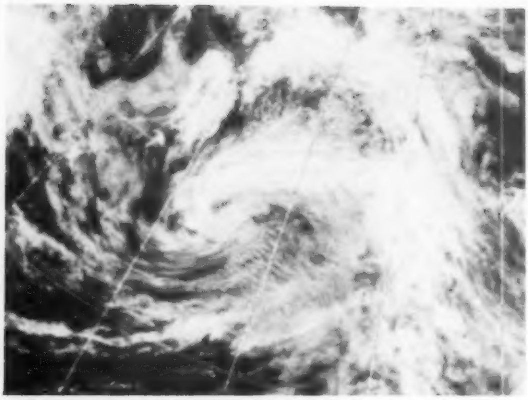

Figure 60.--At the time of this image the high cloud cover indicates the circulation center was near 48°N, 163°E. (DMSP Imagery)

400 mi south of the center with 50-kn winds and 21-ft swells.

On the 7th a SHIP near 49°N, 169°E, was sailing directly into 40-kn winds and 15-ft seas. The seas and swells were reported to be 20 ft by the FORTUNE LEADER. She was west of the cold front near 46°N, 178°E. Later in the day another LOW moved into the southwestern quadrant, and the center looped counterclockwise as the two combined over the Bering Sea. The storm had weakened to a pressure of 996 mb with a weak pressure gradient.

The LOW crossed the Alaska Peninsula into the Gulf of Alaska on the 10th. On the 12th it crossed the coast near Queen Charlotte Island.

Another storm that formed over the Sea of Japan off Hokkaido. This LOW began as a frontal wave on the 16th. The LOW raced eastward and treated the NEPTUNE DIAMOND to 40-kn westerlies. By 1200 on the 18th the 982-mb storm was near 51°N, 170°E. It did not have a large circulation at this time, but the gradient was tight for this time of year. The ASIA MARU was sailing westward into 40-kn gales. On the 19th there were several wind reports in the 40-kn category. The VAN ENTERPRISE reported 47-kn winds at 48°N, 159°E. At least two ships were pounded by 20-ft waves on this day (fig. 61). St. Paul Island measured 40-kn prevailing winds on the 20th. At 1200 Bethel, Alaska, also measured 40-kn winds. The storm's center passed over the coast near Nome at about 0800. Early on the 21st the LOW disappeared.

As the front associated with the LOW above moved to the south, a frontal wave formed between two HIGH cells late on the 19th. On the 21st it was moving almost due north, and there were several reports of gales. The CGC STORIS (52°N, 173°W) reported 38 kn. On the 22d the 990-mb LOW moved to 54°N, 171°E. West of the front a ship reported 16-ft seas. The MAJESTY was many miles to the south, slightly east of the north-south-oriented front, with 40-kn winds. The PRESIDENT PIERCE was south of the Aleutians and east of the front with southeasterly winds of 40 kn. The storm was now moving westward and weakening. It managed

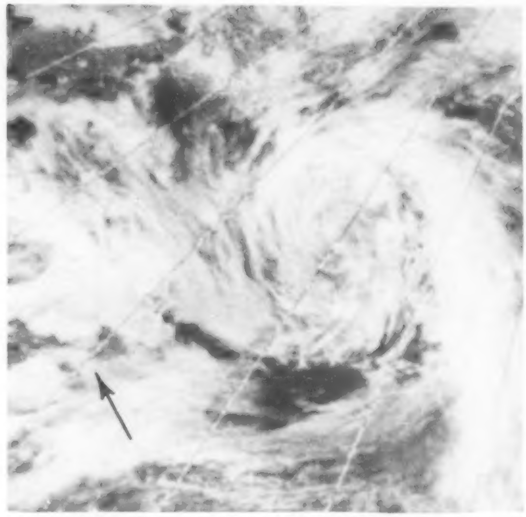

Figure 61.--The storm is centered north of St. Paul Island late on the 19th. A frontal wave is indicated near 43°N, 175°W. The northern cloud band sweeping southwestward out of the LOW is associated with a trough. The pecular-shaped stratus cloud (arrow) at 45°N, 175°E was over a small high-pressure area. (DMSP Imagery)

to survive into the 24th, turning back eastward for a few hours.

Back again to the Sea of Japan for the genesis of this storm, which formed over the Tartar Strait on the 23d. The LOW moved southeast prior to turning northward on the 24th after crossing the Kurile Islands (fig. 62).

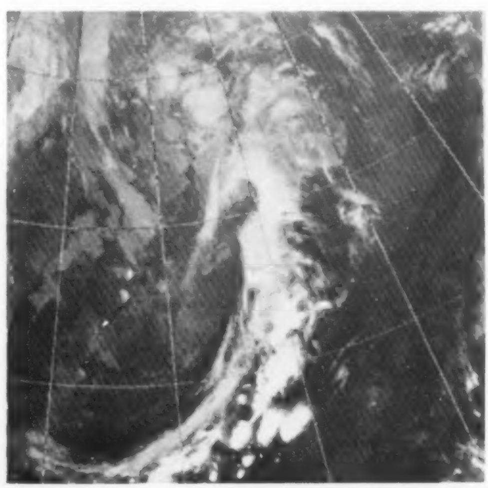

Figure 62.--The storm is centered east of the southern tip of Kamchatka. There is an indication of a frontal wave near 48°N, 160°E. (DMSP Imagery)

As this LOW moved northward it absorbed the remains of the LOW described above. The gradient to the east of the LOW and front was much tighter than it was on the western side. At 0000 on the 25th the LEO was near 49°N, 166°E. She reported being pounded by 58-kn southerly winds. The LOW continued paralleling the coast of Asia until it disappeared.

Tropical Cyclones, Eastern Pacific--Hurricane Iva was detected on the 11th some 200 mi west of Manzanillo. Tracking west-northwestward, she attained hurricane status for a brief period on the 13th. The following day Iva was only tropical storm strength and weakening.

Hurricanes John and Kristy both came to life on the 18th, while tropical storm Lane was born 1 day later. John was in the middle of this near 12°N, 120°W. Kristy was about 600 mi to the east-northeast, while Lane was about 900 mi to the west. John and Kristy moved west-northwestward for several days before joining Lane on a westerly course. John and Lane passed south of the Hawaiian Islands, while Kristy swung to the west-northwest again and passed northeast of the Islands. Kristy reached hurricane strength on the 19th (fig. 63), while John waited until the 22d. By this time Lane had reached his 50-kn peak and was declining as he moved westward along the 14th parallel near 150°W. Kristy was crossing the 120th meridian near 18°N sporting 90-kn winds. Lane faded out by the 24th, while Kristy was generating 80-kn winds and John's winds climbed to 90 kn. The following day Kristy weakened to tropical storm strength as she crossed the 20th parallel near 135°W. John retained hurricane strength until the 26th, but then he began to slip. Kristy lasted until the 28th. John, cruising south of Hawaii along 15°N, hung on until the 30th across 170°W.

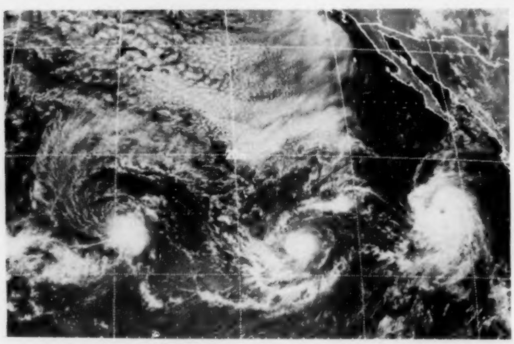

Figure 63.--This NOAA SMS image caught three tropical cyclones at the same time at noon on the 19th. Left to right, they are Lane, John, and Kristy.

While our trio of storms was forging westward toward Hawaii, Miriam was developing around 10°N, 115°W, on the 24th. Remaining a depression until the 27th, Miriam traveled west-northwestward and reached 135°W, where she became a tropical storm. From here on Miriam covered the same waters as Lane and John less than a week before. Miriam reached a peak of 55 kn on the 28th as she crossed 140°W near 13°N. Upon reaching 15°N the following day, Miriam tracked westward slowly dissipating and remaining south of Hawaii. By the 1st she was dissipating near 14°N, 160°W.

As Miriam weakened, Norman came to life on the 30th several hundred miles south of the Gulf of Tehuantepec. He developed rapidly and became a real threat to the fishing fleet. On the 1st and 2d several ships between hurricane Norman and the coast were blasted by 40- to 45-kn winds while cruising in 15- to 30-ft seas. The TEMPLE INN was among these ships. One ship reported 17-ft seas and 38-ft swells about 120 mi northeast of the center. Winds near Norman's center were up to 120 kn by the 3d as he crossed 20°N near 113°W (fig. 64). Norman was paralleling the coast. Although he could not keep his extreme intensity, Norman remained at hurricane strength until late on the 4th near 25°N, 120°W. After this he weakened rapidly as he neared the coast of southern California. Despite this, Norman's rain shield spread to northern California and most of the northwest corner of the Nation. The rain was light but widespread. Almost an inch fell at Strevell, Idaho.

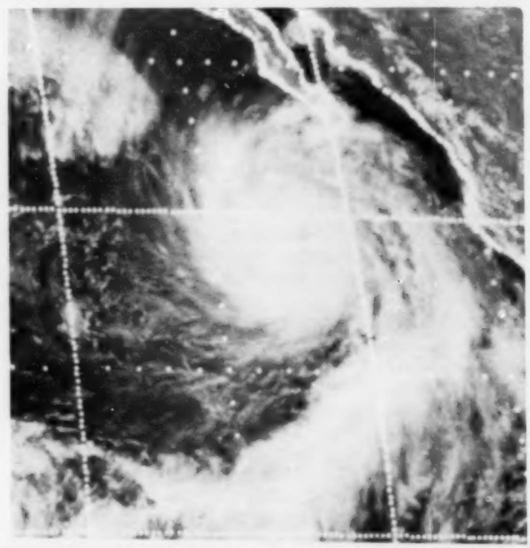

Figure 64.--Hurricane Norman was near his peak in this 2045 September 2 image. He has the classic look with a well-defined eye.

Tropical Cyclones, Western Pacific--Bonnie was spotted moving westward on the 10th in the South China Sea, about 200 mi east of Hainan. The tropical storm crossed Hainan on the 11th. The following day she moved into northern Vietnam. Bonnie's winds reached 40 kn on the 11th (fig. 65).

By this time Carmen and Della were already developing far to the east. Della was detected 300 mi east of Luzon, while Carmen was spotted just north of Saipan. Early on the 13th the OHIKUZEN MARU, some 150 mi northeast of Carmen's center, battled 30-ft swells in 35-kn winds. Carmen was upgraded to a typhoon at this time near 20°N, 140°E. Meanwhile, Della was moving across Taiwan as a 40-kn tropical

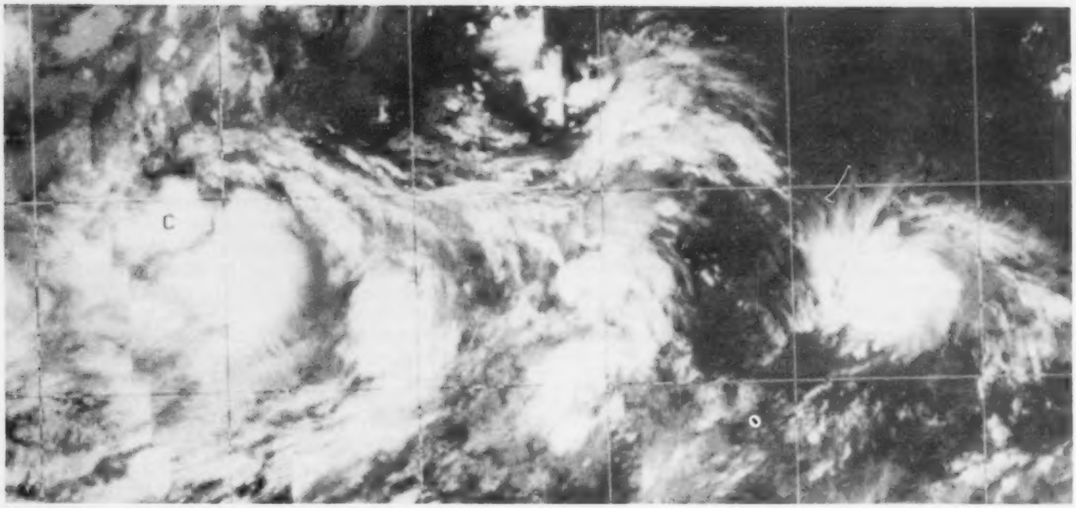

Figure 65.--On August 11 there were three tropical cyclones between 10° and 20°N and 105° to 150°E. Bonnie was near 110°E, Della near 130°E, and Carmen at 145°E. (DMSP Imagery)

storm. The rugged island disrupted her circulation, and she limped ashore on the China mainland late on the 13th as a tropical depression. Carmen roared west-northwestward through the Ryukyus, near Okinawa, packing 75-kn winds. The USNS UTE encountered 40-kn winds late on the 13th some 100 mi to the north of Carmen's center. The East China Sea slowed her down. She began to weaken, and on the 17th she turned northward as a tropical storm. On the 20th Carmen lashed the southwestern tip of the Korean peninsula with torrential rains, flooding farms, villages, and towns. There were 20 deaths with 8 people missing and 4,180 homeless. Property damage was estimated at $20 million.

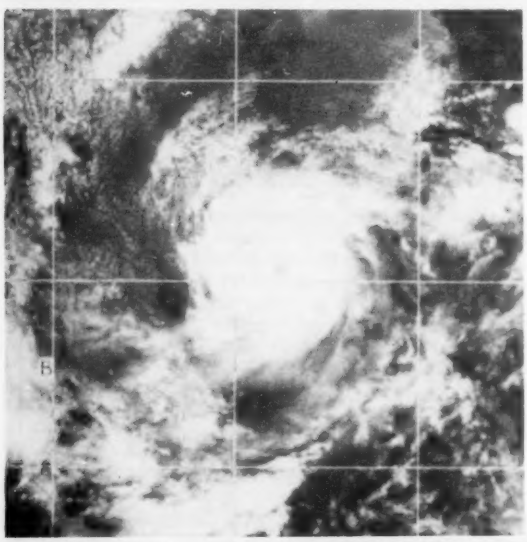

Figure 66.--Typhoon Elaine was at minimal typhoon strength of 65 kn as she approached China north of Hainan Island on the 27th. (DMSP Imagery)

On the 24th the MAASKADE was sailing through the Luzon Strait into 44-kn winds out of the east-northeast. This was the beginning of Elaine who had formed just east of northern Luzon the day before. She moved across the Island and out into the South China Sea, where she intensified and headed west-northwestward. During her 3-1/2 day crossing to mainland China, several ships encountered 20-ft seas and 35- to 50-kn winds. Elaine reached her peak, 65-kn typhoon intensity, just before landfall east of the Lei-chou peninsula on the 27th (fig. 66). Before she dissipated, Elaine made it westward into northern Vietnam on the 28th.

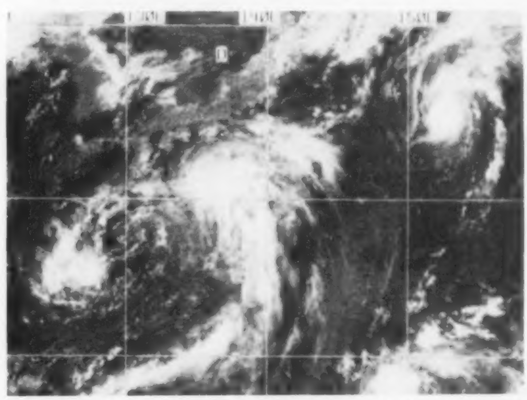

Figure 67.--Dissipating tropical storm Gloria is east of Taiwan, Faye is nearing typhoon strength near 18°N, 150°E, and Hestor is southeast of Tokyo near 35°N, 153°E, on the 31st. (DMSP Imagery)

This was about the time that Faye showed up just east of Guam and within a day of the birth of tropical storm Gloria about 400 mi east of Luzon. Both of these storms took a northerly course. The PRIBOY was run over by Faye early on the 29th and suffered 43-kn easterlies in 23-ft seas. Upon nearing the 20th parallel, Faye turned a clockwise loop as the month came to a close, while Gloria brushed the northern Ryukyu Islands with her 40-kn winds (fig. 67). Gloria fell apart off the coast of Kyushu, while Faye reached typhoon strength on the 1st. As Faye was accelerating northwestward, satellites picked up tropical storm Hester, a late bloomer, near 31°N, 150°E, on the 30th. Hester was moving northeastward and generating 45-kn winds. By the 1st he was becoming extratropical near 45°N, 170°E. This was when Faye was just turning it on. By the 3d her winds climbed to 110 kn as she passed 100 mi southwest of Iwo Jima on a collision course with Japan (fig. 68). However, Japan was spared when Faye turned sharply toward the east-northeast and began to weaken as she crossed the 30th parallel on the 5th. The following day the NOJIMA just south of the center survived 43-kn winds in 26-ft seas. By the 7th Faye was a weakening tropical storm and fast becoming extratropical.

Figure 68.--Typhoon Faye just brushed Iwo Jima on September 3 with southerly winds on her east side. (DMSP Imagery)

Casualties--The 4,743-ton cargo vessel EURCO LINK reported heavy weather damage that occurred between Acajulta and Cristobal on the 13th. The 7,189-ton HOWELL LYKES arrived Manila on the 27th with reportedly heavy weather damage that occurred while enroute from Hong Kong. Tropical storm Elaine was in the area at the time.

ROUGH LOG, SEPTEMBER 1978--There were two primary storm tracks this month. One more or less paralleled its climatological counterpart from Honshu to the Gulf of Alaska. The other corresponded to a secondary climatological track across Sakhalin Island into the Bering Sea. The last week of the month there were several storms that formed south of the Gulf of Alaska and moved northward into the Gulf.

The gross pressure pattern did not differ radically from climatology, but there were quite a few in detail. The largest feature was the Pacific High at 1023 mb. The central pressure was 2 mb higher and at 33°N, 158°W, about 600 mi west of its normal position. The eastern half had the same configuration as climatology with a slight ridging along the coast and mountains. The western half was much broader in a north-south direction than its climatological counterpart. The Aleutian Low had two 1005-mb centers--one near Kodiak and the other near Bethel, Alaska. The climatic center was 1006 mb over Bristol Bay.

The two principal anomaly centers were both 5 mb. The negative one was centered over the Gulf of Alaska near 54°N, 135°W, reflecting the LOW near Kodiak Island. The positive center was near 47°N, 170°W, and reflected the abnormal width of the western part of the Pacific High.

There were significant differences in the upper air flow pattern at 700 mb. The usual long-wave trough along 170°W was replaced by a closed LOW over St. Lawrence Island. There were two trough lines out of this LOW. One stretched southeastward across Bristol Bay and paralleled the North American west coast. The other extended southwestward across the Near Islands to the vicinity of 35°N, 145°E. The long-wave trough inland of the Asian coast resembled a short-wave trough.

There were seven tropical cyclones over the northern Pacific. In the east there was tropical storm Paul and hurricane Olivia. In the west there were typhoons Irma, Judy, Lola, and Mamie and tropical storm Kit.

Extratropical Cyclones--A frontal system that moved off the Asian continent occluded rapidly as it passed over the Kuroshio Current. On the 1200 chart of the 4th a wave was analyzed near 45°N, 152°E. A U.S.S.R. ship was within a few miles of the center with 41-kn southerly winds, 16-ft waves, and a pressure of 998 mb. This report and those of two ships west of the center indicated the wave's formation. On the 5th the PRESIDENT EISENHOWER was east of the front with 35-kn gales. At 2100 the GARDEN STAR and at 0000 on the 6th a SHIP, both near 49°N, 170°E, reported 40-kn winds and 23-ft seas. This position was 200 to 300 mi southwest of the 987-mb center. On the 7th the storm split into two centers with the eastern one dominating as it moved over Alaska.

This LOW was discovered over the Sea of Japan on the 9th. It deepened rapidly late on the 10th as the circulation moved over the open ocean. On the 11th the ship 5MCN was north of the center with 38-kn easterly winds. On the 12th the TAKARA (48°N, 172°E) was sailing into 45-kn northeasterly winds and 12-ft seas. At 1800 on the 13th a SHIP near 53°N, 138°W, reported 49-kn winds and 18-ft seas.

The LOW was headed northward into the Gulf of Alaska on the 14th (fig. 69). The ARCO ANCHORAGE had 43-kn winds near 52°N, 137°W, at 0000. The seas were 21 ft. This was probably the same ship that had the 1800 report of 49 kn. The CHEVRON COLORADO had 52 kn from the south-southeast. At 1800 the OVERSEAS WASHINGTON (53°N, 138°W) was sailing southeastward with 46-kn southwesterly winds and 33-ft swells pounding her starboard side. On the 15th the storm's center passed almost directly over Valdez. At midday the ALEUTIAN DEVELOPER was at 53°N, 140°W, with rainshowers, 37-kn winds, 16-ft seas, and 33-ft swells. The MOBIL MERIDIAN was only 2.5° longitude east with 31-ft swells. The storm broke up on the southern mountains on the 16th.

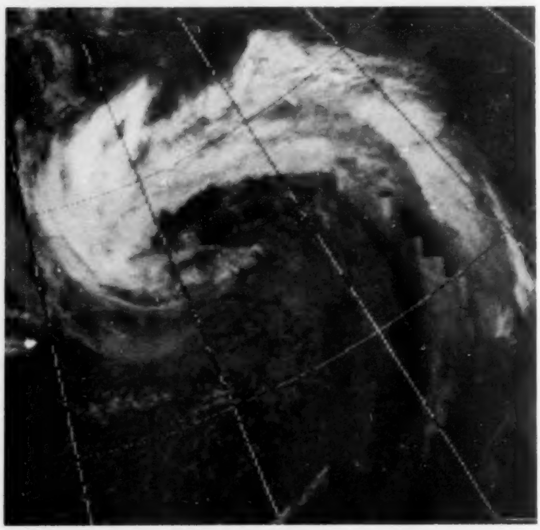

Figure 69.--The high cloud cover is on the north and east sides of the storm. The low-level, warmer clouds are portrayed by the grey south of the center. (DMSP Imagery)

This frontal wave formed near 45°N, 154°W, on the 11th. Twenty-four hours later it was a 980-mb storm near 52°N, 151°W. The ARCO PRUDHOE BAY (54°N, 138°W) had 45-kn gales. The ARCO ANCHORAGE was off the southern coast of Alaska (58°N, 144°W) north of the storm with 70-kn northeasterly winds. At 1200 she reported 65-kn southeasterlies and 20-ft seas. By the 13th the winds had dropped to 35 kn. At 0600 the ARCO FAIRBANKS had 50-kn southeasterlies near Middleton Island. On the night of the 12th and 13th the barge MIAMI in tow of the tug BERING QUEEN broke loose in winds estimated at 50 to 70 kn and 25-ft seas. The barge was found aground on the 13th west of Point Hinchinbrook. At 1800 on the 13th a SHIP near 53°N, 138°W, had 49-kn winds and 18-ft waves. On the 13th the storm moved across the Alaska Peninsula and dissipated.

This storm formed off Hokkaido late on the 16th in the broad circulation associated with typhoon Judy. On the 17th Judy became extratropical as the two low centers combined. Many ships reported gales in the vicinity of 45°N, 148°E. This was over the fishing grounds off Ostrov Iturup.

At 0000 on the 18th, the 982-mb storm was near 44°N, 153°E (fig. 70). A SHIP (47°N, 166°E) was tossed by 43-kn winds, 16-ft seas, and 33-ft swells. One of the Kurile Islands measured 45-kn winds. At 1200 and 1800 a SHIP that moved from near 48°N, 170°E, to 48°N, 172°E, had 45- and 38-kn easterly winds, 33-ft seas, and 57- and 54-ft swells. All parts of both observations looked good. The pressure center was filling, and on the 19th the storm was traveling southeastward.

On the 21st the LOW reached its farthest southern position and again turned north. The central pressure was holding slightly below 1000 mb with the winds below gale force. Heavy rains were recorded in the northeast quadrant. On the 23d the LOW was squeezed out of existence between two high-pressure centers.

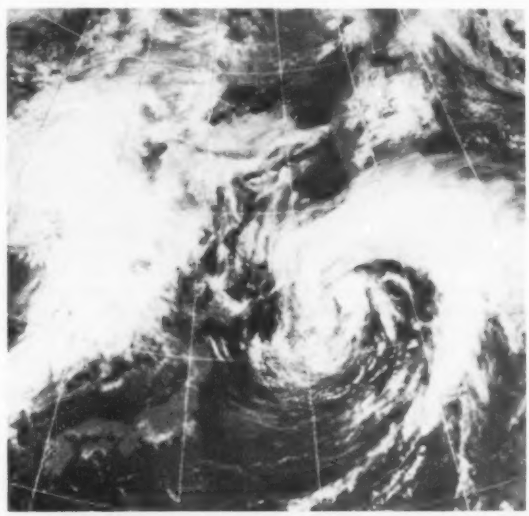

Figure 70.--This storm is due east of Hokkaido. The Japanese Islands and the Kamchatka Peninsula are plainly visible. A beautiful fall day. (DMSP Imagery)

This storm formed only a few hours after the previous one, but it formed over the eastern ocean near 50°N, 160°W. As it moved northward it absorbed another LOW traveling eastward along the Aleutians. On the 19th OWS Papa measured 39-kn winds.

At 0000 on the 20th the large storm--2,000 mi to the east and west by 1,800 mi north and south--was 990 mb over the southern coast of Alaska. The VAN ENTERPRISE was headed toward Cape Flattery with 58-kn winds out of the southeast. At 1800 the YING YUNG was south of Unimak Island. The winds were 40 kn from the west, the seas were 25 ft, and the swells 33 ft. The storm was making a counterclock-

wise loop off the coast (fig. 71), and on the 21st to the 23d it was stationary twice off Dixon Entrance. From the 24th to the 25th a circulation was barely identifiable.

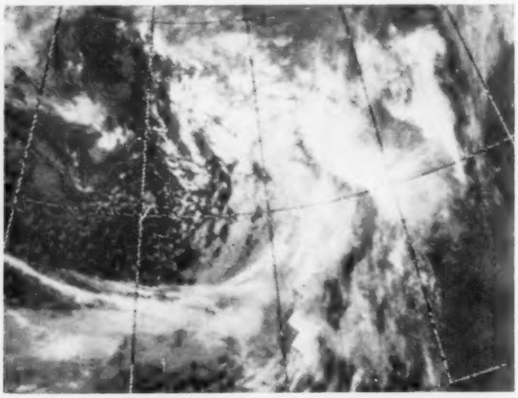

Figure 71.--The clouds are piled up over the Rocky Mountains as the storm stalled off the coast on the 21st. (DMSP Imagery)

This was one of the storms that formed north of Hawaii and off the California coast. The Pacific High had broken down several days earlier with a center over midocean. The first chart on the 25th indicated a large, weak cyclonic flow near 38°N, 141°W. The center moved northward and within 24 hr was 986 mb. At 0600 on the 26th the HAKUSAN MARU was west of the center in the tighter gaadient (46°N, 145°W) with 45-kn winds from 330° and 16-ft waves. At 1800 the OVERSEAS JUNEAU (51°N, 134°W) had 40-kn easterly winds. A SHIP southwest of the center complained of 45-kn westerly winds. Six hours later she had sailed very near the storm's center, recording a 992-mb pressure with 50-kn winds out of the south and 20-ft seas near 50°N, 133°W. At 0600 the EXXON NEW ORLEANS (51°N, 134°W) had southerly 55-kn winds, 991-mb pressure, 33-ft seas, and 38-ft swells.

On the 28th the storm was in the dissipating process and finally disappeared on the 30th as it moved ashore.

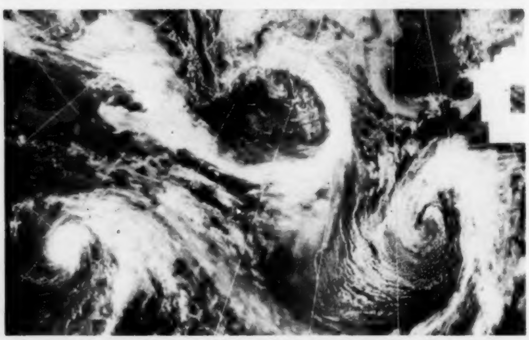

Figure 72.--The storm of interest is near 43°N, 167°W. For a larger view, another storm is off Kamchatka, and tropical storm Mamie is southeast of Tokyo. (DMSP Imagery)

A continuous front stretched nearly across the North Pacific. A frontal wave developed on the front off Honshu on the 30th. By October 2 the 992-mb storm was developing minimal gales. The PRESIDENT MCKINLEY (43°N, 179°W) had 20-ft swell waves on her port beam. At 1800 a SHIP near 39°N, 166°W, found 51-kn winds. On the 3d (fig. 72) the USNS S. P. LEE (35°N, 166°W) was about 500 mi south of the 988-mb center and also had 50-kn winds. She was hammered with 34-ft seas and 41-ft swells. Another ship near 39°N, 166°W, reported 23-ft seas and 33-ft swells.

The BLUE OCEAN was east of the 984-mb center on the 4th with 45-kn winds and 26-ft seas and swells. Later in the day the SEALAND MCLEAN was sailing eastward near 51°N, 148°W, with 40-kn winds, 16-ft seas, and 25-ft swells. On the 5th, another LOW moved into the Gulf of Alaska and absorbed this storm.

Tropical Cyclones, Eastern Pacific--The quiet of September was shattered by hurricane Olivia on the 20th. Born from the remnants of North Atlantic hurricane Greta, Olivia was picked up over southern Mexico. She made it out into the Gulf of Tehauntepec and reached hurricane strength on the 21st (fig. 73).

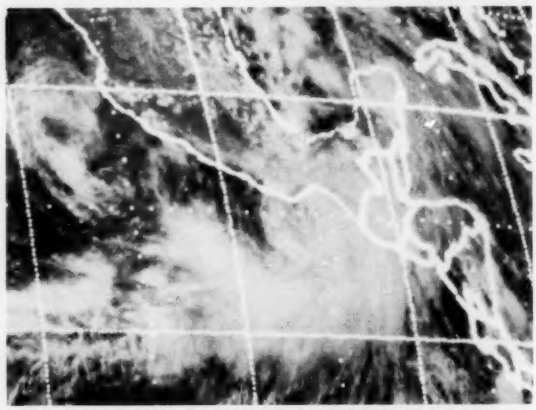

Figure 73.--Although a hurricane, Olivia has a flimsy, hazy appearance, not the hard white of most mature hurricanes. A hazy eye appears to be near 14°N, 95°W.

The following day, packing 65-kn winds, Olivia turned northward, moved back onshore late on the 22d just east of Salina Cruz, and weakened rapidly. Meanwhile, Paul was developing 360 mi to the west-southwest. He paralleled the coast and reached tropical storm strength on the 25th as he crossed the 20th parallel near 109°W. Winds reached 40 kn near Paul's center as he brushed the tip of Baja California. Paul turned northeastward across the Gulf of California and made landfall just south of Los Mochis on the 26th. Later in the day Paul had dissipated into a large area of thunderstorms over north-central Mexico.

Tropical Cyclones, Western Pacific--September's first born was typhoon Irma, nutured in the East China Sea. Christened on the 12th just east of Taipei, the developing youngster headed northward. On the 14th after crossing the 30th parallel, Irma matured into a full-blown typhoon. At this same time, typhoon Judy

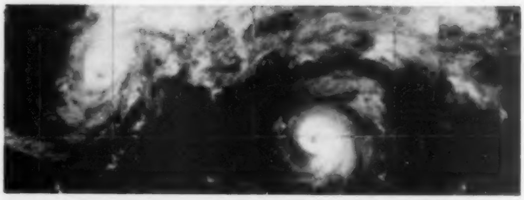

Figure 74.--Typhoon Irma (left) is over Kyushu and Judy on her northeasterly track remained at sea.

had sprung to life 300 mi east of Iwo Jima. She was on a north-northwestward course and reached typhoon intensity on the 14th just before crossing the 30th parallel. Both storms recurved toward the northeast. Irma's winds climbed to 90 kn before crashing ashore over Kyushu on the 15th (fig. 74). At Fukuoka winds were clocked at 89 kn--the highest since the observatory was established in 1939. Torrential rains and high winds caused 5 deaths and thousands of flooded houses. Most of the damage was confined to Fukuoka Prefecture. The recurving of Judy, however, was beneficial to Japan as it kept her and her 90-kn winds out to sea. By the 17th Judy had crossed the 40th parallel near 155°E and was turning extratropical and weakening.

Things were quiet for less than a week, when tropical storm Kit and typhoon Lola moved into the Philippines. Both formed in the Philippine Sea east of the central islands. Kit crossed central Luzon as a tropical depression on the 22d heading west-northwestward. Once into the South China Sea she began to intensify. Mennwhile, Lola was coming to life some 240 mi north of Palau Island. With a little more sea room she was able to reach tropical storm strength before brushing Samar on the 26th. Lola retained her identity as she banged through the central region on a west-northwesterly trek. Kit had passed southwestward on the 23d, gaining tropical storm strength, and on the following day she turned toward the northwest. On the 25th, sporting 50-kn winds, Kit moved westward across Hainan for Vietnam. The following day she made landfall near Ben Thuy and turned southward. The rain-soaked area could ill afford a tropical storm. Nine provinces in the south were struggling with flooding, which had devastated the Mekong Delta rice belt last month. Meanwhile, Lola passed over Manila on the 27th. Her journey left her weak, but the

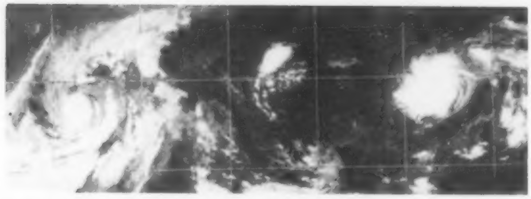

Figure 75.--Typhoon Lola is approaching Hainan Island on the 30th, while typhoon Mamie is just forming south of Marcus Island. (DMSP Imagery)

invigorating waters of the South China Sea quickly restored her. By the following day Lola was a typhoon heading toward the northwest. Winds near her center reached 75 kn (fig. 75). On the 1st Lola crossed northern Hainan. The following day as a weakening tropical storm, she moved onto the mainland near the Vietnam-China border.

Just before the month ran out Mamie showed up midway between Saipan and the Marcus Island. She headed northward and intensified. By the 2d as she reached 25°N, she began to recurve toward the northeast. She reached typhoon strength on the 3d just after crossing the 30th parallel (fig. 76). Peak winds reached 70 kn. Mamie was already pretty far north, so cool air began to intrude into her circulation. By the 4th she was once again a tropical storm as she accelerated rapidly northeastward.

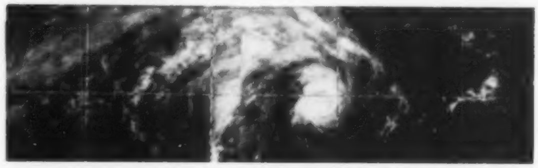

Figure 76.--Mamie is nearing typhoon strength of 64 kn early on October 3, slightly south of latitude 30°N.

Casualties--The 9,085-ton British-registered SEA MOON requested a survey for heavy weather damage while at Kobe on the 4th. The night of September 9 and 10 a cold front moved onto the Oregon coast and sank many fishing boats. The 14,800-ton Brazilian LLOYD GENOVA ran aground in heavy weather near Salina Cruz, Mexico, on the 22d.

Marine Weather Diary

NORTH ATLANTIC, DECEMBER

WEATHER. December is generally one of the stormiest months of the year over the North Atlantic, particularly north of 35°N. Deep and extensive LOWs traverse the middle and northern shipping lanes, producing strong winds and high seas. Extended periods of rain, sleet, or snow usually attend these storms. A comparison with the normal pressure pattern of the preceding month shows that in December the Azores High remains at about 1021 mb and is centered near 35°N, 33°W. The Icelandic Low deepens 1 mb to 1001 mb; it is located near 62°N, 38°W.

WINDS from the westerly quarter prevail over most of the ocean north of 40°N. Speeds average force 5 to 6 over most western and central waters, and about force 4 over the Bay of Biscay and surrounding waters, the Baltic Sea, and the southern portion of the North Sea. Force 5 to 6 southeasterlies prevail over the northern half of the North Sea, while southerlies of force 4 to 5 are predominant off the central coast of Norway. Winds over the Norwegian Sea are variable at about force 5. Between 40° and 30°N, winds (force 3 to 4) are westerly or southwesterly west of 20°W, northerly or northeasterly between 20°W and the Strait of Gibraltar, and predominantly westerly over the

Mediterranean Sea. The "northeast trades," also averaging force 3 to 4, persist between 30° and 10°N, except off the east coast of Florida where winds are variable at force 4. As in November, force 3 southeasterlies prevail over the extreme southern North Atlantic.

GALES. The occurrence of gales is more frequent over northern and middle latitudes than in November. Winds of force 8 or higher occur 10 percent or more of the time from about 34°N over the western North Atlantic to about 40°N over eastern waters. A 10-percent frequency of gales is encountered on the Mediterranean Sea within an area extending nearly 200 mi southeastward from the Gulf of Lions. The incidence of gales is less than 10 percent over the immediate waters east of Newfoundland and over the Davis Strait. Areas of maximum gale frequency--20 percent or higher--are found within an area from the Labrador Sea southeastward to about 44°N, 35°W, then north-northwestward to 56°N, 40°W, then eastward to 55°N, 24°W, then north-northwestward again to the cold waters off southeast Greenland; over much of the Norwegian Sea; and over the Gulf of Lions.

EXTRATROPICAL STORMS. Two primary storm tracks--one from the waters east of the United States Middle Atlantic States and one from the northern Great Lakes--converge over Newfoundland and then head toward Greenland, where they split into two tracks with one leading into the Davis Strait and the other heading toward Iceland. A large number of LOWs also head toward Iceland from the central ocean east of 40°W and north of 50°N. Another cyclone track enters the Davis Strait from Hudson Bay, while still another runs across the northern coast of Norway from the Norwegian Sea. A primary track stretching from the Gulf of Lions to west-central Italy and then east-southeastward to the south coast of Turkey influences the Mediterranean area. The Great Lakes have their highest cyclone frequency of the year during December. The frequency of cyclogenesis over the Gulf of Mexico also reaches it annual maximum during December.

TROPICAL CYCLONES. There is seldom a tropical storm on the North Atlantic in December. During the 45-yr period, 1931-75, only two were recorded; one of these reached hurricane strength.

SEA HEIGHTS of 12 ft or higher occur 10 percent or more of the time north of a line extending from the northwest coast of Spain to approximately 35°N, 70°W, and then east of a line joining that point with Nova Scotia. On the Norwegian Sea, however, sea heights $\geq$ 12 ft usually occur less than 10 percent of the time. Ten-percent frequencies are also found in the Mediterranean between Balearic Islands, Sardinia, Tunisia, and the French Riviera; between Sicily and Crete; and on the northern Aegean Sea. Maximum frequencies of 30 percent or more occur over the Denmark Strait and over much of the western and central ocean north of about 47°N and south of the 60th parallel. An isolated area of 20-percent frequency rests over the Gulf of Lions.

VISIBILITY. The frequency of visibility less than 2 mi climbs to 10 percent over the Labrador Sea, over a pocket-shaped area extending from Kap Farvel southsouthwestward to the Grand Banks, over the southern and eastern Davis Strait, and over the southern North Sea. Frequencies of this low visibility are also greater than 10 percent over the area north of a line drawn from the Denmark Strait eastward across northern Iceland, then dipping southward to about 64°N, 7°W, then stretching north-northeastward over the Norwegian Sea, and then eastward to the northern coast of Norway. North of about 72°N, the frequency of visibility less than 2 mi increases to 20 percent and continues to increase as one moves eastward until, after reaching the southern Barents Sea north of the Soviet Union, frequencies reach a maximum of 40 to 50 percent.

NORTH PACIFIC, DECEMBER

WEATHER. December is usually a stormy month over North Pacific waters, particularly in the northern and middle latitudes. The normal pressure distribution is quite similar to that of the preceding month with the Aleutian Low (1001 mb) shifting to near southeastern Kamchatka.

WINDS north of 55°N blow mostly from a northerly direction at force 4 to 6, except over the Gulf of Alaska where force 4 easterlies prevail. Westerly winds of force 3 to 6 are usually felt south of 55°N to about 40°N over the extreme eastern ocean, 35°N over the central-eastern and midocean, and 30°N west of 165°E and east of Japan. Nevertheless, winds over the southwestern Bering Sea show a tendency to be variable, and off the coast of British Columbia the prevailing wind is southerly. Steady "northeast trades" prevail (force 4) between 25°N and the Equator, except they extend to nearly 35°N off the southwestern California coast. These trade winds merge with the force 4 to 5 winds of the northeast winter monsoon near 140°E. Variable winds (force 3 to 4) lie in a narrow belt between the aforementioned westerlies and northeasterlies. Prevailing winds are largely from the north or northwest and average about force 4 over the Sea of Japan, and the Yellow Sea, and along the southeast coast of Japan. Northerly winds blow steadily out from the Gulf of Tehuantepec, off the south coast of Mexico.

GALES. A larger area of the North Pacific is subject to gales during December than in the preceding month. North of about 39°N over eastern and central waters and 32°N over western waters, 10 percent of the observations contain winds of force 8 or higher. The greatest frequencies, 20 to about 25 percent, occur in three scattered areas from the waters south of the southern tip of the Kamchatka Peninsula south-southeastward to about 34°N, 166°E. Farther north, the frequency of gales decreases to less than 10 percent over the Sea of Okhotsk and the Bering Sea. They are also under 10 percent across a triangularly shaped area southeast of the Aleutians bounded at 53°N, 162°W; 47°N, 163°W; and 49°N, 174°W. Gales are recorded between 5 and 10 percent of the time on the waters surrounding Taiwan, the southern Ryukyus, and the northern portion of Luzon as far east as 144°E, because of the strong development of the northeast monsoon. Gale-force northerly winds occur between 5 and 10 percent of the time out from the Gulf of Tehuantepec.

EXTRATROPICAL CYCLONES. Primary storm tracks extend from the northern portion of the Sea of Japan and the waters east of the Ryukyus to the ocean region lying between Kamchatka and the western Aleutians. From there, LOWs either pass near the Pribilof Islands or continue east-northeastward to the Gulf of Alaska. Another major storm track reaches the Gulf of Alaska from an area south of the Alaska Peninsula near 48°N. The only other primary cyclone track swings toward Vancouver Island from a point 450 mi west of the Oregon coast.

TROPICAL CYCLONES. One tropical storm usually develops over the western North Pacific during December. About two out of every three that do pop up go on to become typhoons. The most likely area of formation is in the neighborhood of the Caroline Islands. Contrary to the events of November, very few of these storms are able to maintain their identity over the South China Sea after traversing the Philippines.

Off the Mexican west coast, tropical cyclones are rare in December.

SEA HEIGHTS of at least 12 ft occur 10 percent or more of the time north of approximately 35°N, east of 150°E, and south of the Alaska mainland, the Aleutian Islands, Kamchatka, and 55°N on the Sea of Okhotsk.

VISIBILITY under 2 mi occurs 10 percent or more of the time north of a line drawn from the lower Tatar Strait to the central Kurils and then northeastward to the western Aleutians where it dips southeastward to about 47°N, 177°W. Upon reaching a point near 47°N, 165°W, the line bends generally northward to Cape Romanzof, Alaska. A much smaller area of 10-percent frequency is centered near 44°N, 143°W. Visibility less than 2 mi encompasses more than 20 percent of all observations poleward of a line cutting through the northern and eastern portions of the Sea of Okhotsk, the northern Kurils, and then northeastward through the Bering Sea to the Bering Strait (passing west of both the Komandorskiye Islands and St. Lawrence Island). A smaller area comprising a 20 percent or greater frequency lies north of the central Aleutians near 54°N. 173°W.

NORTH ATLANTIC, JANUARY

WEATHER. January is generally characterized by rough weather over the middle and northern latitudes of the North Atlantic. LOWs frequently become deep, and associated winds often reach gale and sometimes hurricane force. The Icelandic Low (1000 mb), centered off the extreme southeastern tip of Greenland, is deeper than at any other time of the year. The Azores-Bermuda High with a central pressure of about 1023 mb covers a band from the western Mediterranean Sea west-southwestward to the waters northeast of the Bahamas.

WINDS. North of 40°N, the prevailing winds are westerly over most of the ocean. Over the Norwegian Sea and the North Sea, winds from the southerly quarter prevail. The average wind speeds are predominantly force 4 to 6, except up to 1,200 mi south and east of the southern tip of Greenland and over the Labrador Sea where they reach force 5 to 7. Between 25° and 40°N, the wind direction is from the southwest quarter of the compass over the main body of that portion of the Atlantic, mostly easterly over the Gulf of Mexico, variable over the waters east of Florida, and northerly or northeasterly from west of the Iberian Peninsula to the Canary Islands. Westerlies still dominate over the Mediterranean Sea. Force 3 to 4 winds are the most common except off the coast of the middle Atlantic United States where force 4 to 6 winds prevail. From the Equator to 25°N, the "northeast trades" persist; more than 65 percent of the time wind speeds range from force 3 to 5, except south of 10°N where these winds blow more than 50 percent of the time.

GALES (winds force 8 and higher) occur in 10 percent or more of the observations north of 35°N over the western part of the ocean and north of 40°N over the eastern part. The Mediterranean Sea hosts 10-percent frequencies out to 150 mi from the Gulf of Lions, over the northern Adriatic Sea, and over most of the Aegean Sea. The highest frequency over all North Atlantic waters, 30 percent, is found over a small area centered at about 58°N, 30°W, over a narrow belt off the southern tip of Greenland between 38° and 52°W, and (because of the mistral) over the Gulf of Lions.

EXTRATROPICAL CYCLONES. During the winter months (December, January, and February) LOWs form most frequently in a band 150 to 250 mi wide stretching from the North Carolina - South Carolina border northeastward to about the latitude of Cape Cod. This is part of a large area of cyclogenesis that extends from the Gulf coast of the United States northeastward to the Bay of Fundy. Other principal areas of cyclogenesis lie over the western half of the central ocean between Newfoundland and the British Isles, over most Icelandic coastal waters, over the inland waters east of the North Sea except the Gulf of Bothnia, and over the Mediterranean from the Gulf of Lions southeastward to the toe of Italy and then northward to the Yugoslavia coast. Cyclogenesis is more concentrated around the waters on both sides of central Italy than anywhere on the North Atlantic during winter with the exception of the band off the United States Atlantic coast. In January, primary storm tracks run from the Carolina capes to Cape Race and from Lake Superior to Cape Bauld. After reaching Newfoundland, cyclones either head northward to the Davis Strait or the Denmark Strait or northeastward to Iceland. Primary storm tracks are also present off the northern Norwegian coast, over the Mediterranean from the Gulf of Genoa to Cyprus, and over the eastern Great Lakes where they join the track toward Newfoundland.

SEA HEIGHTS greater than 12 ft occur 10 percent or more of the time north of 33°N over the western North Atlantic and north of 42°N over eastern waters. Frequencies greater than 10 percent also exist in a small area near Barranquilla, Colombia, and on the Mediterranean between Menorca and Sicily (not including the waters surrounding Corsica), south of Greece and west of Crete, and on the northern Aegean Sea. A large area of frequencies greater than 30 percent stretches from south of Iceland to west of Ireland to east of the Grand Banks and then northward to the waters southwest of Greenland and south of the waters between Greenland and Iceland. Smaller areas of similar frequency are found on the Denmark Strait and west of northern Norway near 67°N, 10°E. The frequency of sea heights greater than or equal to 12 ft decreases to less than 10 percent over a large portion

of the Norwegian Sea north of 67°N between 5°E and about 13°W.

VISIBILITY less than 2 mi is noted in more than 10 percent of the observations from Cape Sable eastward to the Grand Banks and northward to Cape Mercy, over the Denmark Strait and the northwestern portion of the Norwegian Sea, and over the southern portion of the North Sea. The frequency increases to more than 20 percent in the Resolution Island area and over the Norwegian Sea north of about 70°N.

NORTH PACIFIC, JANUARY

WEATHER. The most severe weather of the year occurs generally in January over the middle and northern latitudes of the North Pacific. The circulation over the ocean is controlled mainly by the major centers of action--the Aleutian Low, the subtropical High, and the Siberian High. All except the subtropical High are near or at their peak seasonal development. The Aleutian Low, with a central pressure of 1000 mb, is southeast of Kamchatka near 50°N, 165°E, while the axis of the Pacific subtropical ridge exceeds 1021 mb from about 30°N, 135°W, east-northeastward to the State of Wyoming. The wind regime near the Asiatic coast from the Korea Peninsula to the South China Sea is controlled principally by the clockwise flow around the Siberian High (1036 mb), situated over Asia near 49°N, 96°E.

WINDS. Westerly winds prevail over much of the ocean north of 30°N and west of 180°. Northerly winds dominate the East China Sea. Winds are variable over the western Aleutians, southeasterly over the central Aleutians, and northeasterly near the Pribilof Islands. From the Gulf of Alaska southward to near 40°N and east of 180°, winds are mostly westerly to southerly, although other directions are common during the frequent passage of LOWs. Over the extreme northern Gulf of Alaska, the prevailing winds are easterly, and northerly winds are very pronounced over the Bering Sea north of 60°N. The average speed of winds north of 30°N is force 4 to 6, although southeast of Kamchatka the wind blows at force 7, 21 percent of the time. The "northeast trades" extend northward to near 25°N over most of the western and central ocean and to 30°N over eastern waters; south of 20°N, these winds are very steady. The wind speeds in the trades range from force 3 to 5. The "northeast monsoon" is steady over the South China Sea and the Philippine Sea south of 30°N and west of 150°E. Winds are quite variable over the eastern North Pacific between 30° and 40°N, southwesterly over the east-central ocean between 25° and 40°N, and variable over west-central waters between 25° and 30°N and 150°E and 180°. Wind speeds over the above three areas are usually force 4. Northerly winds predominate over the Gulf of Tehuantepec, and in 65 percent of the observations they range between force 2 and 6.

GALES. The frequency of gales near and above 10 percent affects most noncoastal areas south of the Aleutians and north of a line from the waters southeast of Honshu to a point south of the Queen Charlotte Islands and west of Washington State. A maximum incidence of over 20 percent is found over a relatively large region southeast of Kamchatka, over a smaller area east of northern Honshu near 39°N, 154°E, and south of the Gulf of Alaska near 50°N, 145°W. Gale-force northerly winds are encountered more than 10 percent of the time by vessels plying the Gulf of Tehuantepec off southern Mexico. These violent squally winds occur when strong northers from the Gulf of Mexico funnel across the isthmus to the Pacific. In extreme cases, they may be felt more than 200 mi out at sea.

EXTRATROPICAL CYCLONES. Principal areas of cyclogenesis during winter are found from Taiwan on the southwest to the northern Kurils and lower Sakhalin on the northeast and from just north of Marcus Island on the southeast to the western shore of the Sea of Japan on the northwest. The Yellow Sea and Korean coastal waters are not included in this vast region of cyclogenesis. Other smaller areas of cyclogenesis lie over the Pribilof Islands, the Gulf of Alaska, off the North American coast from the Queen Charlotte Islands southward to northern California, and over the east-central ocean about midway between the Aleutian and the Hawaiian Islands. The migratory LOWs move mostly northeastward from the East China Sea and Hokkaido to the western Aleutians and then east-northeastward to the Gulf of Alaska. Other primary tracks approach the Gulf of Alaska and Vancouver Island from the southwest.

TROPICAL STORMS are infrequent in January. On the average, two can be expected every 5 yr over the western North Pacific. Most of these storms develop between 6° and 10°N and west of 150°E and move toward the southern half of the Philippines. Three out of every five January tropical storms achieve typhoon strength.

SEA HEIGHTS greater than 12 ft occur more than 10 percent of the time in an area extending northward from 30° to 35°N to a line drawn from Kodiak Island to the central Aleutians and then to the southeastern waters of the Sea of Okhotsk, and westward from a line 700 mi off the coast of southeastern Alaska and 500 mi off the Oregon coast to 150°E.

VISIBILITY less than 2 mi occurs in 10 percent or more of the observations over an area of the eastern North Pacific between 40° and 50°N and 141° and 162°W, and northwest of a line drawn from Hokkaido to the western Aleutians and then northeastward along the Aleutian chain to the Alaska Peninsula and Cape Avinof. A maximum frequency of over 30 percent encloses a small area over the Okhotsk Basin southwest of Kamchatka.

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